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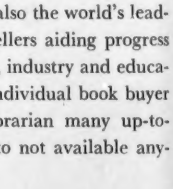

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Mobilization against Influenza

The high effectiveness of vaccination with formalin-inactivated influenza virus was demonstrated during the widespread epidemics of influenza A in 1943 and of influenza B in 1945, largely through the studies in military personnel conducted by the Commission on Influenza of the Armed Forces Epidemiological Board. In later years of low incidence the commission's repeated studies have provided confirmatory evidence that appropriately constituted vaccines are highly protective. It was established, however, with equal confidence that vaccine of the same composition was not effective in the 1947 epidemic caused by a virus variant which was termed "A-prime." Despite efforts to compound a vaccine which would contain components covering the range of antigenic variants, the Asian strains of 1957, isolated by Army laboratories in the Pacific, although belonging to type A, were promptly demonstrated by Hilleman, of the Walter Reed Army Institute of Research, to possess a dominant antigen different from those of recent years. The information was promptly transmitted to all agencies concerned with studies of influenza.

In historical perspective, one of the most striking features of the current epidemic of influenza is how typical it has been, to date, at least. Influenza is, however, a capricious disease, varying from mild and scattered flurries to the world-wide hurricane of 1918. Hence, recognition that an epidemic of influenza is launched on a global orbit always brings with it concern about its subsequent behavior. Because of its speed of travel, there may be little time to prepare.

In May there was a rapidly extending epidemic of high incidence and increased mortality in crowded areas of Asia, associated with a new variant of influenza virus. United States military units in those areas had also been affected. It was inevitable that the United States would be involved and, even though the disease was mild, high incidence could create serious functional dislocation. If severe, the nation's effectiveness might be seriously taxed.

The one proven method of protection against the oncoming wave was vaccination. Although biological manufacturers of influenza vaccine had had ten years of experience in producing relatively large amounts of varied formulae, getting a new strain into large-scale production requires time and major adjustments. If, as predicated, the disease was to become widely epidemic in the United States by early autumn, action was necessary. Virus was distributed immediately, then, to a number of research laboratories for study and appraisal of its unique characteristics and was also sent to the manufacturers for exploratory processing and preparation of experimental lots of vaccine. The world-wide network for influenza detection could follow the epidemic meanwhile for better documentation of its distribution and severity and for significant changes in its behavior.

Conferences of experts in influenza vaccine were called to consider potency requirements and time schedules. The Commission on Influenza, the Walter Reed Institute, and the Communicable Disease Center began

early in June actual studies of the potency of experimental lots of vaccine in human subjects. Information about the practicable potency of vaccine which could be produced in reasonable time and quantity was determined, and impetus to its production was given by purchase orders from the Armed Forces. The National Institutes of Health, in close collaboration with the manufacturers, took responsibility for assuring standard potency and safety of vaccine.

In the meantime, the Public Health Service exerted outstanding leadership toward mobilizing civilian health and medical resources for effective and efficient handling of a large epidemic. In this there was close collaboration with the American Medical Association, state and territorial health officers, the American Hospital Association, the military medical services, manufacturers of antibiotics, and other essential lay and professional groups. Among the questions which had to be considered were priorities in the use of limited supplies of vaccine and hospital beds, the conservation of the medical practitioners' services, the care of the patient, the use of antibiotics, and the maintenance of community facilities and industrial production. In addition, funds were provided to support laboratories in the identification of epidemic prevalences, and further financial support was made available for desirable research upon problems presented by the epidemic.

Much attention has been given to providing current information on the status of the epidemic to the professions and to the public. The National Office of Vital Statistics provides weekly bulletins. Through the Communicable Disease Center a weekly Surveillance Report presents up-to-date details of spread, incidence, mortality, industrial absenteeism, and vaccine release. The preparation of this report is made possible by cooperation with the World Health Organization as well as with the numerous active agencies in this country. The Epidemic Surveillance Unit has sent its officers into epidemic areas for aid in investigations, and the Influenza Committee of the American Medical Association has taken steps to keep the profession informed and to urge effective community action.

A group from commissions of the Armed Forces Epidemiological Board conducted studies for a month in Chile during the winter season of August and September. The purpose was to learn in advance of its appearance in the United States more of the effect of the epidemic in an area usually exhibiting high mortality from respiratory disease. The observations of the group were important in that no unusual features were noted; pneumonic cases were seen to respond to treatment as in other years.

The Commission on Influenza has maintained in certain military establishments continued studies of vaccination against influenza. It was able to institute by the end of July carefully controlled investigations of the effectiveness of materials of different antigenic strength. In the early occurrence of epidemics at these posts, it has already demonstrated that the vaccine has a minimal effectiveness estimated to be from 45 percent (with early materials of low potency) to 75 percent (with later preparations of greater strength). Based on these and antigenic studies by various investigators, the decision was made to increase the potency from the earlier level to one that stimulates a response approximate to that of a person recovering from the disease.

It will be interesting to watch carefully the progress of this 1957 epidemic and the new information it will provide. It is already clear that the virus is not entirely new to our population but bears relationships to strains in circulation 30 or more years ago; so far this is reflected in the decreased incidence in older age groups. Speculators may place bets on two waves, three waves, or home permanents. But the evidence is against further marked change in severity of a virus which has already been passed so many times in susceptibles.

The entire development has been a remarkable demonstration of cooperation and coordination of research and application toward the meeting of an impending emergency. It could not have been possible earlier, or even now, were it not that major differences in scientific interests and theory have been amalgamated into a unified approach to an applied problem in national security.

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Experiments on Motivation

Studies Combining Psychological, Physiological, and Pharmacological Techniques

Neal E. Miller

The importance of motivation in both normal and abnormal behavior is generally recognized. For example, the proper regulation of hunger is vital if the extremes of either malnutrition or obesity are to be avoided; psychotherapists have found that it is much more effective to deal with the underlying motivation in a psychogenic disorder than to treat a specific symptom.

This article (*1, 2*) describes experiments from our laboratory in which a combination of behavioral, physiological, and pharmacological techniques is used to study motivation. The experiments deal with hunger, thirst, sex, aggression, and a centrally aroused pain-fear-like response. These drives are induced or reduced in a variety of unusual ways, such as by direct electrical or chemical stimulation of the brain.

Our main reason for manipulating drives in unusual ways is to learn more about the mechanisms of the drives themselves and more about the roles of drives in learning and performance.

A subsidiary reason is to test a specific hypothesis, the drive-reduction hypothesis of reinforcement. It is well known that turning off a strong motivational stimulus, such as an electric shock, will serve as a reward to reinforce whatever response the animal was making just before it escaped from the shock. It is also known that food will serve as a reward for a hungry animal and that this same food will reduce the strength of the hunger drive. The drive-reduction hypothesis attempts to abstract a common element from such observations. In its weak form, it states that the sudden reduction in the strength of any strong motivational stimulus always serves as a reward, or, in other words, is a sufficient condition for reinforcement. In its strong form, it states that all reward is produced in this way, or, in other words, that drive reduction is the necessary and sufficient condition for reinforcement.

Although I believe that the strong form of this hypothesis has much less than a 50 percent chance of being correct, I have been interested in subjecting it to rigorous tests. Actually, the correlation between reward and satiation does not tell us anything about the causal relationship; it could be a spurious correlation built into the organism by conditions of natural selection which have eliminated animals that were not pleasantly rewarded by conditions that reduced their drives. But if this correlation is such a spurious one, it might disappear when drives are manipulated in unusual ways not involved in natural selection.

Finally, the results of these studies show the value of using a diversity of rigorous behavioral tests to determine, point by point, whether the effects of the unusual interventions, such as electrical stimulation of the brain or administration of drugs, have all the functional properties of normal increases or reductions in drive. It is on this methodological point that we begin.

Some Studies of Hunger

Most studies of hunger have used but a single technique, measuring the amount of food consumed. If one is interested only in problems of energy exchange, the caloric intake obviously is the relevant measure. But if one is interested in the broader aspects of hunger as a drive to motivate the learning and performance of foodseeking behavior, it is not safe to rely solely on this measure.

In an early study, Miller, Bailey, and Stevenson (*3*) studied the motivational effect of a bilateral lesion in the region of the ventromedial nuclei of the hypothalamus, which studies summarized by Brobeck (*4*) had shown would cause rats to overeat until they became very fat, like the one shown in Fig. 1. Because this lesion produces such a large increase in food intake, one might assume that it also has the more general effect of increasing hunger. We tested this assumption by using a behavioral measure—the rate at which the rats will work at the task of pressing a bar to secure food when they are rewarded on a variable-interval schedule. In this test, which was developed by Skinner (*5*) at Harvard, hungry animals are first trained to press a bar actuating a device which automatically delivers tiny pellets of food. Then the device is set so that pressing the bar pays off only at unpredictable intervals, although the average frequency of pay-off remains constant. Under these conditions, the rate of bar pressing is quite constant at a given level of food deprivation but changes when the level of food deprivation is changed. Hence, the rate of working for food on these terms seems to be a relevant measure of hunger. But to our surprise, the animals with lesions, which were eating reliably *more* than the controls, worked reliably *less* at the bar to secure food.

The two measures—volume of food consumption (consummatory response) and rate of bar pressing—yielded opposite results. To resolve this dilemma, we devised a variety of other tests. One of these involved putting simple lids on the food dishes. When the lids were unweighted, the test animals ate more than the normal controls did, but when 75-gram weights were put on, the difference was reversed. In order to control for factors such as motor dexterity and fatigue, we imposed an entirely different type of deterrent to eating: the food was made progressively more bitter by adulteration with quinine. This quite different type of deterrent also caused consumption on the part of the test animals to fall below that of the controls. Similarly, it was found that the test rats ran more slowly down an alley to food than the controls did, pulled less hard when temporarily restrained by a harness, and were stopped by lower levels of electric shock at the goal. These results prove that, under the

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conditions of our experiment, the lesions did not have the same general motivational effects as a normal increase in hunger had.

Further thought stimulated by these results makes it clear that the amount of food consumed *ad libitum* is not determined by how hungry the animal gets after moderate or extreme periods of deprivation but rather by the low levels of hunger that keep the subject nibbling before it is completely satiated.

Some Techniques Used

The next experiments involved a small plastic fistula sewn into the stomach of the rat, threaded under the skin up its back, and emerging immediately behind its ears. Figure 2 shows an x-ray picture of a barium solution being injected into a rat's stomach through such a fistula. Figure 3 shows a picture of a rat with two such fistulae. One ends in a rubber balloon, which can be used to distend the stomach or to record stomach contractions; through the other an enriched milk solution is being injected directly into the stomach. (For purposes of photography, black rubber tubes were slipped over the smaller translucent plastic tubes of the projecting fistulae.)

The rat shown in Fig. 3 is in the act of pressing a bar which causes a disk below to rotate and bring it a cup containing three drops of milk. In other experiments, pellets of food or drops of water are used. During the later stages of training and testing, pressing the bar does not always deliver reward; it works only at variable, unpredictable intervals.

The same apparatus is used for the quinine test. The bar is removed, and a different cup is rotated into place automatically once every 30 seconds. Each cup contains three drops of liquid adulterated with quinine hydrochloride in amounts that increase progressively from concentrations of 0, 0.004 percent, 0.008 percent, and 0.016 percent up to 1 percent. For each cup that it cleans up, the rat receives 2 points; for each one that it starts without finishing, 1 point; and for cups that it does not touch, 0.

Comparison of Four Measures of Hunger

In one study performed with this apparatus, Miller and Marion Kessen (*6*) compared the effects of hours of food deprivation on four different measures of hunger. The results are shown in Fig. 4. It can be seen that, under the conditions of these experiments, the volume of food (in this case, an enriched milk solution) drunk in a given period—a figure which presumably would have been at a very low level initially had we had the wit to give tests immediately after satiation—had approximated its maximum after 6 hours of deprivation and did not increase appreciably thereafter. Although the reduction in eating observed after 30 hours is not statistically reliable, other work in our laboratory and elsewhere has demonstrated a similar reduction at longer intervals in animals habituated to a 24-hour feeding cycle. As shown in Fig. 4, the curve for stomach contractions seems to parallel that for volume of milk drunk. But the other two measures, rate of bar pressing and amount of quinine required to stop the animal from drinking, follow a different course, continuing to increase throughout the test period. From these results it seems reasonable to conclude that hunger continues to mount for at least 54 hours but that the volume of food consumed in a limited time reaches a ceiling determined by the volume of the stomach or by the ability of the body to handle the food.

The results of these two experiments clearly show that it is desirable to supplement the measure of amount of food consumed with other behavioral tests.

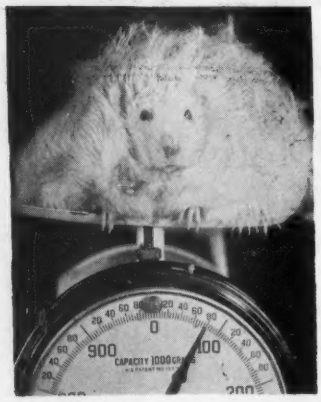

Fig. 1. Effects of excessive eating caused by lesions in the hypothalamus of the rat. [Photo by J. A. F. Stevenson]

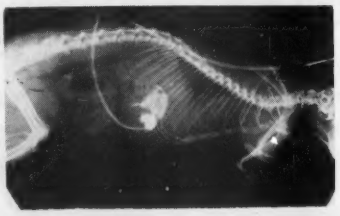

Fig. 2. X-ray picture of rat with fistula chronically implanted into the stomach. A barium solution is being injected.

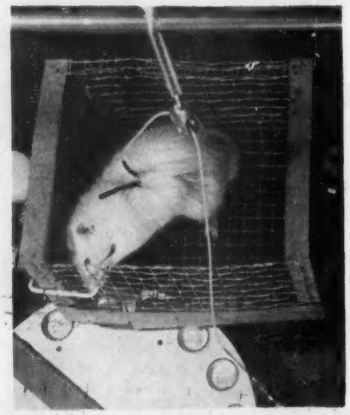

Fig. 3. Hungry rat pressing bar to secure reward of three drops of enriched milk. Through one fistula connected to a syringe, additional milk can be injected directly into the stomach; through the other fistula, a balloon in the stomach can be inflated. To make the small transparent fistulae visible, black rubber tubes have been slipped over them.

Oral Versus Gastric Factors

If hunger were not reduced until tissue needs were restored, the long delay between eating and drive reduction would make drive reduction by eating ineffective as a reward; the animal would also be motivated to continue after it had eaten enough. Therefore, satiation probably is controlled, at least in part, by other mechanisms. These logical considerations are backed up by the subjective reports of patients with fistulae and by the results of certain animal experiments, which have been limited, however, to the single measure of food consumed (*7*). The following experiments in our laboratory were designed to secure more comprehensive information on such mechanisms.

Kohn (*8*) compared the effects of 14 milliliters of enriched milk drunk normally by mouth with those of 14 milliliters of milk injected via fistula directly into the stomach or of 14 milliliters of isotonic saline injected directly into the stomach as a control. He measured hunger by an instrumental response—the rate of bar pressing reinforced on a fixed-interval schedule. Berkun, Kessen, and Miller (*9*) ran a parallel experiment comparing the effects of the same three treatments—14 milliliters of milk drunk normally by mouth, 14 milliliters of milk injected directly into the stomach, and 14 milliliters of isotonic saline injected directly into the stomach. They measured hunger by the consummatory response—the volume of enriched milk the rat would drink to satiation immediately after a given treatment.

Figure 5 shows that both measures produce similar results; milk injected directly into the stomach produces a prompt reduction in hunger, but milk drunk normally by mouth produces an

even greater reduction. Furthermore, when Kohn's results are analyzed for successive 3-minute intervals, it is evident that the effects appear immediately and that there is no tendency for them to get progressively greater during the 30-minute test, as would be expected if digestion and absorption into the blood and tissues were an appreciable factor. These results suggest that there are at least two means of producing immediate reductions in hunger, one involving the mouth and throat and the other, the stomach.

As a different means of investigating the role of the oral factor, we used a sweet-tasting but non-nutritive substance, saccharin. Previous experiments by Sheffield and Roby (*10*) have shown that saccharin serves as a reward for hungry animals. Therefore, the strong form of the drive-reduction hypothesis demands that saccharin should also be found to reduce hunger.

A series of experiments by Miller, Roberts, and Murray (*11*) confirmed the deduction by showing that prefeeding with saccharin solution reduces both the subsequent consumption of that solution and the rate of bar pressing reinforced by saccharin. It also reduces the immediately succeeding consumption of dextrose, milk, lab chow, or fat. But the effects of saccharin are less than those of an equally "preferred" solution of dextrose. Perhaps the most interesting result is that shown in Fig. 6. It can be seen that saccharin, when drunk normally by mouth, has a definite effect, but that when it is injected via fistula directly into the stomach it has no effect. This is in contrast to our results with nutritive substances, which have both oral and gastric effects. Perhaps the absence of a gastric effect explains why saccharin seems to produce less of a reduction than equally "preferred" dextrose.

The results of these experiments with saccharin provide additional evidence of a separate oral drive-reducing effect independent of the restoration-of-tissue needs; they also confirm the deduction from the drive-reduction hypothesis of reinforcement.

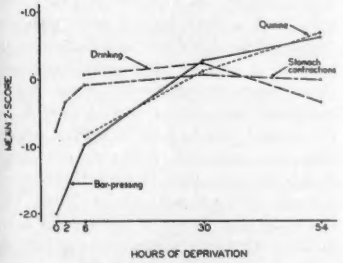

Fig. 4. Comparison of four measures of hunger: (i) drinking—the volume of enriched milk required to satiate the rats; (ii) the amount of adulteration with quinine required to prevent eating; (iii) the rate of bar pressing reinforced by food on a variable-interval schedule; and (iv) sum of excursions of the record of stomach contractions measured from a balloon permanently implanted on the end of a plastic fistula. [From Miller (*6*)]

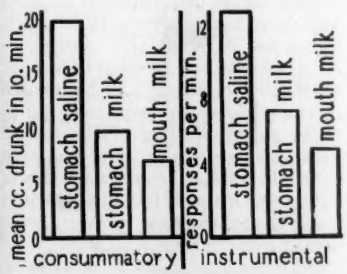

Fig. 5. An injection of 14 milliliters of enriched milk directly into the stomach reduces hunger more than does the same volume of isotonic saline, but milk drunk normally by mouth produces still greater reduction. The same pattern of results is shown by both measures: the volume of milk consumed and the rate of performing an instrumental response (bar pressing) rewarded by food on a fixed-interval schedule. [Data from Kohn (*8*) and Berkun, Kessen, and Miller (*9*)]

Reward by Direct Injection of Food into the Stomach

If food injected directly into the stomach produces a prompt reduction in the strength of hunger, the drive-reduction hypothesis of reinforcement demands that such injection should serve as a reward to produce learning. But since food taken normally by mouth produces a greater reduction, it should serve as a stronger reward. In order to test this deduction, Miller and Kessen (*12*) performed an experiment in a simple T-maze. One group of hungry test animals found a dish of isotonic saline if they turned to the left and a dish of milk if they turned to the right. Another group received an injection of isotonic saline via fistula directly into the stomach if they turned to the left and an injection of milk if they turned to the right. (For half of each group the positions of the milk and the saline were reversed. All animals were given a second trial each day, during which they were forced to the side of the maze opposite to that selected on their first, free-choice trial.)

As Fig. 7 shows, both groups learn to choose the correct side 100 percent of the time on free-choice trials, but the group getting milk by mouth learns much more rapidly. Similar learning curves are also shown by the time scores.

These results support the drive-reduction hypothesis by showing that milk injected directly into the stomach can serve as a reward. They run counter to other hypotheses which would make either the performance of the consummatory response or the taste of the food the sole source of reward, although they do not rule out these factors as additional sources of reward. Furthermore, these results serve as a control to eliminate the possibility that the reductions in the rate of bar pressing and in the amount of food consumed observed in the previous experiments were produced solely by a conflicting drive, such as nausea induced by the unnatural injections via fistula, rather than by a genuine reduction in hunger.

Effects of Stomach Distension

The preceding studies controlled for volume of fluid injected into the stomach. But since saline solution may easily leave the stomach, they did not necessarily control for stomach distension. In order to study the effects of distension, Miller and Kessen (*11*) prepared animals with two fistulae, one of the normal kind and the other ending in a small thin rubber balloon in the stomach. The rat in Fig. 3 has two such fistulae. Figure 8

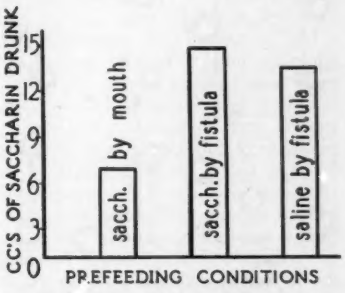

Fig. 6. Saccharin injected directly into the stomach by fistula has approximately the same effects as a control injection of a saline solution with the same osmotic pressure, but saccharin drunk normally by mouth greatly reduces the subsequent consumption of saccharin.

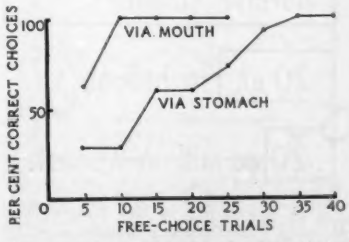

Fig. 7. Hungry rats rewarded by milk injected directly into their stomachs learn to choose the correct side of a T-maze, but other rats, drinking milk normally by mouth, learn more rapidly.

shows that distension of the stomach by inflating the balloon with 20 milliliters of fluid markedly reduces the rate of bar pressing and that distension by injection of 20 milliliters of milk directly into the stomach reduces the rate slightly more. The greater effectiveness of the milk, though slight, was statistically highly reliable.

Stomach distension by milk and by balloon have markedly similar effects on rate of bar pressing. Do both types of distension produce similar reductions in the hunger drive? If the hunger drive is reduced by inflation of the balloon, the drive-reduction hypothesis would lead one to expect that such distension would serve as a reward for the hungry rat. To test this deduction, hungry rats were run in the simple T-maze with the balloon inflated when they went in the goal box at one side but not when they went in the goal box at the other side. As Fig. 9 shows, instead of learning to go to the side where the balloon was inflated, the animals learned to avoid it. Although stomach distension by milk and by balloon have similar effects on the rate of bar pressing, this new learning test shows that these two types of distension produce qualitatively different effects. There is some mechanism in the stomach which reacts differentially to the food and to the balloon.

One interpretation of this result is that, while the milk reduces the rate of bar pressing by reducing hunger, the balloon reduces it by inducing a conflicting motivation, such as nausea. A *post hoc* assumption of this kind is not satisfying, however, unless it can be supported by additional evidence. If distension of the balloon induces some other motivation, such as nausea, we should be able to use the reduction in this motivation, when the balloon is deflated, as a reward to reinforce new learning. We are in the

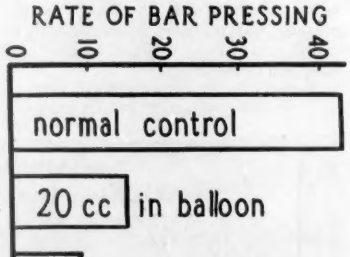

Fig. 8. Distension of the hungry rat's stomach by inflating a balloon with 20 milliliters of fluid reduces the rate of working for food, but distension by 20 milliliters of milk injected directly into the stomach produces a slightly greater reduction.

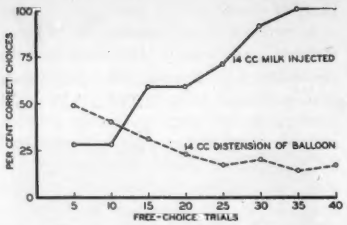

Fig. 9. One group of hungry rats learns to choose the side of a T-maze where their stomachs are distended by milk injected via fistula; another group learns to avoid the side where their stomachs are distended by inflation of a balloon.

process of trying to confirm this prediction, but our preliminary results so far have been negative. We also have preliminary results suggesting that inflation of the balloon may produce a much greater reduction in the rate of bar pressing than in other measures of motivation. These two results, though still tentative, cause us to be cautious; we may be forced to some different interpretation.

In any event, it is clear that it was worth while to use the additional test, which differentiated the rewarding effects of distension by milk from the aversive ones of distension by the balloon.

Hunger-Motivated Habits Elicited by Stimulating Brain

In his monumental, pioneering work on stimulation by means of electrodes chronically implanted in the brains of cats, Hess (*13*) reports that eating, and even the gnawing of inedible objects, can be elicited by stimulating certain points in the hypothalamus. Recently, Smith (*14*) has reported similar results with rats. In our laboratory, Edgar Coons and I are studying this phenomenon to see whether it has some of the more general motivating properties of hunger. The possibility that it is merely a reflexlike gnawing response is raised by the fact that stimulated animals will frequently bite off and chew inedible objects such as pieces of wood.

Our tests have involved determining whether or not the electrical stimulation of the brain which elicits eating in the satiated animal will also elicit various habits that have been rewarded by food when the animal was hungry. In one experiment hungry rats were trained to press a bar which delivered the reward of food on a variable-interval schedule. Next, the rats were thoroughly satiated, first in the home cage and then in the bar-pressing apparatus. Finally, the satiated rats were tested with alternate 2-minute periods of stimulation by means of the electrode that would elicit eating and of nonstimulation. Each time the rat pressed the bar, a recording pen moved up a small distance. Whenever the bar delivered a tiny pellet of food, the pen drew a spike below the curve.

Figure 10 shows the photograph of a record of the results. The almost horizontal lines of the record during the 2-minute periods of nonstimulation show that the rat pressed the bar very infrequently during these control periods. The upward steps, starting relatively soon after the onset of stimulation and ending relatively soon after its termination, show that electrical stimulation of this point in the brain motivated bar pressing. The median rate without stimulation was 0.5, and with stimulation 8.5, responses per minute.

In another apparatus we have trained rats to run, when thirsty, to the nozzle of a water bottle and drink and to go, when hungry, to a different place and push back a small hinged door to secure pellets of food hidden in a little trough behind it. When thoroughly satiated, these rats were relatively inactive until electrical stimulation was delivered to the critical area in their brains, at which time they soon ran to the proper place and repeatedly pushed back the hinged door to get and eat pellets. Thus, the electrical stimulation of the specific area in the rat's brain seems to have had at least some of the general properties of normal hunger in that it will elicit not only eating but also the performance of learned, food-seeking responses.

Coons is now investigating whether stimulation in this area has another of the properties of hunger: Will turning off such stimulation serve as a reward?

Studies of Thirst

Oral versus gastric factors in thirst have been investigated by Miller, Sampliner, and Woodrow (*15*). The results are similar to those found with hunger: water injected directly into the stomach of rats produces a prompt reduction in thirst, measured either by the rate of working at pressing a bar to get water or by the amount of water consumed; water taken normally by mouth produces a still greater reduction in thirst, measured in either of these ways.

Other experiments are in progress on the effects on thirst of stomach distension produced by a balloon on the end of a plastic fistula and on the effects of injecting saline or water directly into the blood stream by means of a catheter permanently implanted into a vein. Working with the latter technique, Donald Novin is especially interested in trying to determine whether the sudden increases in thirst induced by hypertonic injections via the catheter into a vein can

be a means of conditioning to produce a learned drive and whether the reduction in thirst produced by injections of water into the vein can serve as a reward in a simple learning situation.

Minute Injections into Ventricles of the Brain

Andersson (*16*) in Stockholm found that minute injections of hypertonic saline into the region of the third ventricle of goats would cause them to drink, presumably by stimulating osmoreceptors in the brain. In order to see whether this result would be repeated with cats and whether injections of water would have the opposite effect, Miller, Richter, Bailey, and Southwick (*17*) permanently implanted hypodermic-needle devices in the third and lateral ventricles of the brains of cats. Tests were made on cats which were moderately thirsty so that we could note either increases or decreases in drinking.

The results are shown in Fig. 11. It can be seen that the amount consumed after a minute injection (0.15 milliliter) of isotonic saline is no different from that after a mock procedure in which nothing is injected. Apparently this volume of fluid has no effect per se. But when the injection is slightly hypertonic (2 percent of sodium chloride), the volume consumed is increased. This result confirms Andersson's results with goats.

Conversely, it can be seen that an injection of 0.15 milliliters of distilled water decreases consumption. This new finding shows that minute injections of hyper- and hypotonic solutions have opposite effects.

A second experiment, by Miller, Richter, Lacy, and Jensen (*17*), showed that the effects demonstrated in the experiment just described are not limited to the response of drinking but include some of the more general motivational effects produced by normally-induced thirst. In order to secure water, cats were trained to pull in spoons mounted radially on a disk. During the later stages of training and throughout testing, the water was placed in the spoons on a variable-interval schedule. In extensive tests, different doses of either a 2 percent sodium chloride solution or pure water were administered in a balanced order between mock injections. The injections of hypertonic saline reliably increased the rate of performing the learned response rewarded by water, while the injections of water reduced it.

These results, together with those of the afore-mentioned experiments, show that the regulation of thirst can be effected by mechanisms located in at least three places: mouth-throat, stomach-intestine, and brain.

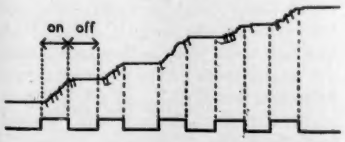

Fig. 10. A cumulative record of a satiated rat repeatedly performing the learned habit of pressing a bar for food when the brain stimulation is on, and seldom performing it when the brain stimulation is off. The downward spikes on the record indicate the times when pressing the bar on the variable-interval schedule actually paid off with a pellet of food.

Are Certain Drives Heterogeneous Clusters?

Most of us are accustomed to thinking of a given drive, such as thirst, as a single unitary variable. If a drive really is a single unitary variable—representing the activity of a single substance in the blood, a central state, a center or an integrated system in the brain—it is obvious that all pure measures of the drive should be perfectly correlated.

On the qualitative level, our experiments on oral versus gastric factors show the type of agreement which would be expected if drives are unitary factors. The measures of amount consumed and rate of bar pressing both agree in showing that normal consumption, by mouth, produces more drive reduction than does an injection made directly into the stomach but that the latter produces some reduction. Such agreement is shown for both hunger and thirst. In the case of thirst, these measures agree in showing that a minute injection made directly into the third ventricle, if hypotonic, decreases drive and, if hypertonic, increases it. In the case of hunger, an additional measure, learning in the T-maze, shows the reward effects to be predicted from the other two measures—namely, more rapid learning when food is administered by mouth than when it is administered by stomach, but some learning under the latter condition. Furthermore, electrical stimulation of the brain has similar effects on two different measures: it elicits the consummatory response of eating and also the performance of learned instrumental responses rewarded by food.

When the stomach is distended by a balloon, however, there is disagreement; distension reduces the rate of bar pressing but acts as a punishment rather than as a reward. This result cannot be accounted for by a single unitary factor, and it forces us to assume a second factor, such as nausea induced by distension.

Although the experiments just reviewed show an impressive amount of agreement among measures, it should be recalled that the first experiments described in this article show some disagreement. We found that the lesion in the hypothalamus increases one presumptive measure of hunger—the amount of food consumed—while it decreases other measures such as the rate of bar pressing and the amount of quinine required to stop the animals from eating. In the second experiment, we saw that the volume of food consumed fails to increase with more than 24 hours of deprivation, while other measures, such as bar pressing and quinine scores, continue to increase. Other studies from our laboratory, summarized elsewhere (*6*), have yielded additional discrepant results. For example, Miller and Levine find that a certain dose of amphetamine increases the rate of bar pressing which has been reinforced by food but decreases both the quinine score and the amount of food consumed. Similarly, Choy finds that a strong saline solution, administered by stomach tube to animals which have just eaten dry food, decreases the rate of bar pressing for water but increases the amount of quinine required to stop the animals from drinking and increases the amount of water consumed.

Such discrepant results can be explained in two ways: (i) by assuming that the drive is not a single unitary intervening variable but rather a cluster of interrelated variables such as might be expected if a number of neural centers are involved which are differentially affected by various regulators and have differential effects on various response systems; or (ii) by assuming that the drive is a unitary variable, perhaps integrated by a single neural mechanism,

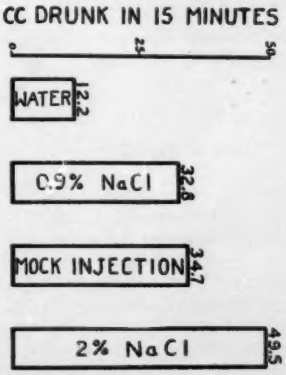

Fig. 11. Effects on thirst of minute injections into the ventricles of the cat's brain. The two controls, 0.15 milliliters of isotonic saline and a mock injection, produced similar effects. An injection of 0.15 milliliters of water reduces subsequent drinking, while injection of the same amount of slightly hypertonic saline increases subsequent drinking.

but that the measures are impure and hence can be affected by factors other than the drive. For example, the rate of bar pressing might be susceptible to a stimulating side-effect of amphetamine, which might more than compensate for that drug's interference with hunger.

The possibilities we have been discussing open up new problems for research which will require experimental designs that have seldom been used by behavioral scientists. As has been pointed out elsewhere (*18*), the type of experimental design required (but almost never used) to make intervening variables, such as drives, meaningful is one in which it is possible to compare the effects of a number of different experimental operations on a number of different measures of the variable. The concepts of physical science are convincing and useful because their functional unity and generality is confirmed by tests of this general design. Thus, electricity produced by a variety of different experimental operations—by an electrostatic machine, a chemical reaction in a battery, or the wires of a generator cutting magnetic lines of force—has the same effects on a variety of means of measuring electricity—repelling like charges on an electrometer, depositing silver in an electroplating bath, and creating magnetic lines of force which deflect the needle of a meter. Similarly, on a highly quantified level, electrons from diverse sources all have exactly the same charge, which can be measured by a variety of independent techniques.

The fact that there is a word in the English language to describe a phenomenon does not guarantee that it has generality and functional unity of the type we have just illustrated. Perhaps, as we are forced to modify some of our concepts because they do not have this type of unity, we may eventually "carve nature better to the joint" and achieve more powerful concepts which do have such generality and unity.

Learning Motivated by Electrical Stimulation of the Brain

The first experiments to demonstrate instrumental learning motivated by electrical stimulation of the brain were designed to use a number of different techniques to show whether a pain-fear-like "alarm" reaction to central stimulation had all of the functional properties of normally aroused pain and fear. Normally aroused pain and fear have the following properties: (i) their evocation can motivate and their termination can reinforce the learning and performance of instrumental responses; (ii) they can be used to establish a conditioned response; (iii) they can be used to condition, in the test subject, an emotional disturbance to new stimuli which will provide motivation for the learning and performance of new responses; (iv) they can serve as a punishment to establish an approach-avoidance conflict, so that a hungry animal will avoid food. Delgado, Roberts, and Miller (*19*) performed the experiments described below to show, point by point, that electrical stimulation of certain places in the diencephalon (*20*) has all of the foregoing properties.

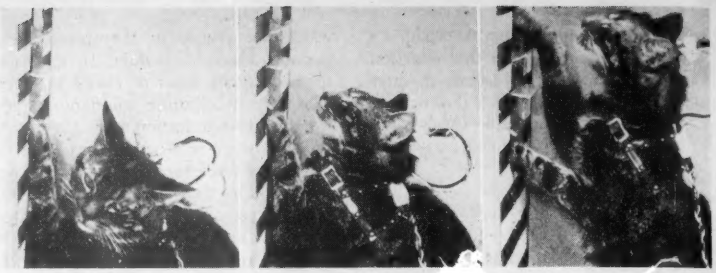

Fig. 12. The learned instrumental response of rotating a paddle wheel to avoid shock to the feet is elicited by direct electrical stimulation of specific points in the brain. The stimulus was turned on between taking of the first and second pictures. [Selected frames from a motion picture shown by me at the meetings of the American Psychological Association, September 1953]

In the first experiment, cats were placed in an apparatus one end of which contained a little paddle-wheel device, rotation of which turned off the stimulation. When critical points in their brains were stimulated, the cats, which had previously been trained to escape electric shock in the same apparatus, became active, until by chance, aided by transfer from their previous training, they rotated the wheel and turned off the stimulation. After a number of such trials they learned to rotate the wheel immediately when the stimulation was turned on. Figure 12 shows successive frames from a motion picture of a cat performing this response when its brain is stimulated.

In the second experiment, a tone was used as a conditioned stimulus. This tone preceded the centrally aroused emotional disturbance. The cat had to rotate the wheel to turn off the central stimulation, but if it rotated the wheel in time, it turned off the tone and avoided the central stimulation. At first, the tone elicited no response, but after a number of avoidance-conditioning trials, the cats learned to respond promptly to the tone and thus to avoid the central stimulation.

In the third experiment, the cats were placed in an apparatus consisting of two distinctive compartments separated by a partition, in the upper front corner of which was a hole just large enough to allow them to climb through. During initial tests they showed no marked preference. On training trials, they were locked into one of the compartments and stimulated there. After a number of such trials they showed obvious signs of fear of that compartment. Then, on test trials, without any further central stimulation, the hole between the two compartments was opened. During these trials the cats rapidly learned the new response of escaping by climbing up through the narrow hole to the other compartment. Control cats, stimulated in a sensorimotor area with a higher voltage which produced an apparently more violent motor response, did not learn to be disturbed in the compartment or to avoid it.

In the final experiment in this series, hungry cats were trained to eat fish from a dish and were then stimulated just as they started to eat. Test cats, stimulated at the critical point, learned in one or two trials to stay completely away from the food. Control cats were stimulated in the sensorimotor cortex with a higher voltage, which produced a more violent lurch back from the food. With proper placement of electrodes, the cats could be made to pull violently back from the food for many trials without learning any avoidance of the food.

The foregoing experiments have shown, point by point, that the particular emotional reaction elicited by electrical stimulation of the cat's brain has all of the functional properties of externally elicited pain and fear: (i) its evocation can motivate and its termination can reinforce the learning and performance of an instrumental response; (ii) it can be used to establish a conditioned response; (iii) it can be used to condition an emotional disturbance to a distinctive test compartment, after which, during trials in which there is no further stimulation, the cat learns to escape from that compartment; and (iv) it can act as a punishment to teach hungry cats to avoid food.

Some Unexpected Effects

Figure 13 shows a response of extreme activation which Roberts and I observed in a cat stimulated in the vicinity of the posterior hypothalamic nucleus. Follow-

ing Hess (*13*), we called this a "flight" reaction. In spite of all of the superficial indications of strong motivation, we discovered to our surprise that large numbers of trials failed to produce any obvious sign of emotional conditioning in the two-compartment apparatus. Therefore, we tentatively concluded that it did not produce any learning.

Fortunately, we decided to give additional tests to prove the obvious. Again we were surprised. We found that if the cat was stimulated for 5 seconds before it was placed in the start of a T-maze and if the stimulus was turned off only after the cat had run to the correct arm of the maze, it learned within a few trials to dash to the correct side as soon as the stimulus was turned on; the cat demonstrated rapid escape learning. But even after 200 additional trials, the cat still failed to show any avoidance learning; it sat calmly waiting until the stimulus was turned on.

In a subsequent, rigorously controlled study, Roberts (*21*) has shown that cats motivated by centrally elicited "alarm" or peripheral "pain" will rapidly learn to avoid the stimulus by leaving the starting box before the stimulus is turned on. Cats stimulated at "flight" points will learn as rapidly to run to the correct side after the stimulus is turned on but will not learn to avoid the stimulus by starting during the 5 seconds before it is turned on. In these experiments, a level of "flight" stimulation was selected which appeared to be stronger than that of "alarm" or of peripheral pain in that it would cause the animals to run faster and to pull harder against a temporary restraint than did the other two types of stimulus.

Fig. 13. "Flight" response elicited by stimulation in the vicinity of the posterior hypothalamic nucleus. To our surprise, the stimulation eliciting this response was also rewarding.

While further investigating the "flight" response, Roberts (*22*) made another unexpected discovery. He found that, although cats would learn to run to the correct arm of a T-maze in order to escape "flight" stimulation, paradoxically they would learn to press a bar in order to get stimulation of the same voltage at the same point. In other words, they would show not only a rewarding effect from the *termination* of presumably aversive stimulation, as originally demonstrated in the hypothalamus by Delgado, Roberts, and Miller (*19*), but also a rewarding effect from the *onset* of stimulation analogous to that found in the septal area by Olds and Milner (*23*). Previously, these two effects had been observed only from different places, and it is indeed surprising that they should both be elicited from stimulation at the same point in the brain. Furthermore, looking back at Fig. 13, I believe it is clear that, from observation alone, one would not suspect that stimulation at the point where such a response is aroused could function as a reward. Again, the need for rigorous behavioral tests is demonstrated.

Subsequently, Gordon Bower and I have secured the same paradoxical rewarding and aversive effects by stimulating in the hypothalamus of rats along the medial forebrain bundle near the fornix. Figure 14 shows a picture of a rat exhibiting these paradoxical dual effects of reward and punishment. It can be seen that this rat has learned to run to a bar and press it in order to turn on electrical stimulation of his brain. Once the bar has been pressed, the stimulation continues until it is turned off by rotation of a wheel. Having worked at the bar to turn on the stimulation, the rat then runs to the wheel to turn it off and after that, returns to the bar to turn it on, repeating the sequence over and over.

The *simultaneous* elicitation of rewarding and punishing effects would be clearly contrary to the drive-reduction hypothesis, since rewards should involve reductions, and punishments should involve increases, in drive. But such a phenomenon would also run counter to all other current notions of reward and punishment, since these two concepts seem to be mutually exclusive, by definition. While we should not hesitate to reexamine radically our time-honored definitions, there are at least three other possibilities here, involving successive effects: (i) that we are stimulating a single system that responds with pleasant sensations at first, which continue to increase until they become unbearable; (ii) that we are stimulating a single system but that the stimulation has first an inhibiting, drive-reducing, rewarding effect followed by a drive-inducing, punishing effect; or (iii) that we are stimulating two different adjacent systems which have different temporal characteristics, so that the reward is predominant first and the aversion thereafter. The first of these possibilities would be contrary to the drive-reduction hypothesis; the second two, which must be considered also in other tests of this hypothesis, would be congruent with it. Furthermore, it is possible that an initial reward effect is what prevented Roberts' cats from showing avoidance learning.

However the theoretical problems may be resolved, these paradoxical effects show the practical need for systemati-

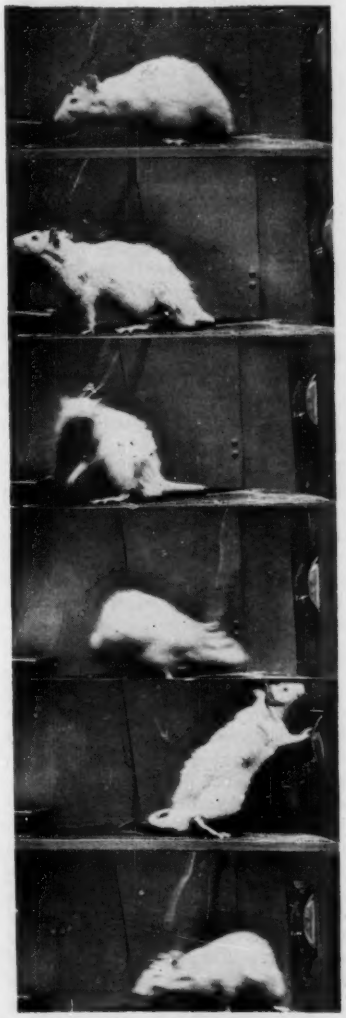

Fig. 14. A rat presses a bar to turn on electrical stimulation of his brain, rotates a wheel to turn it off, and continues to repeat this sequence. [Pictures taken by Martin Iger in our laboratory for Harcourt, Brace and Company]

Fig. 15. An attack response elicited by stimulating a cat. This particular response was conditionable but probably was elicited by pain produced by stimulating beneath the base of the brain. In other cats we have not been able to condition apparently similar rage responses elicited by stimulation in the hypothalamus.

cally submitting each logical, and illogical, possibility to rigorous behavioral tests.

Effect of Drugs on Rewarding and Punishing Functions in the Brain

The paradoxical dual effects of stimulation in the medial forebrain bundle near the fornix may give us a technique for discovering drugs that accentuate the positive, rewarding functions of the brain or minimize the negative, punishing ones. Similarly, drugs with differential effects may help us to analyze the functions of motivational systems in the brain.

A promising start has been made, and described in an unpublished paper, by Robert Kirschner, who used an apparatus which consisted of two bars, one black and one white, but otherwise similar, placed diagonally across from each other in the corners of a square box. Pressing one of the bars turned the stimulation on; pressing the other bar turned it off. Both the rate of bar pressing and the total time of stimulation were recorded.

After exploring a number of drugs, he selected methamphetamine and chlorpromazine. When the cycle for pressing of both bars was recorded, he found that both drugs produced marked and similar depressions in the over-all rate: methamphetamine reduced the rate to 16 percent of that recorded after a control injection of isotonic saline, and chlorpromazine, to 12 percent. But when the positive and negative components were measured separately, there was a striking difference. Methamphetamine *increased* the speed with which the stimulus was turned on to 270 percent of the control rate and *reduced* the speed with which it was turned off to 11 percent of the control rate. By contrast, chlorpromazine reduced the speed of turning on the stimulus to 5 percent of the control rate and that of turning off the stimulus to 56 percent of the control rate.

The fact that methamphetamine appeared to potentiate the rewarding, and reduce the punishing, effect seems to fit in with the clinical observation that it tends to produce euphoria. The fact that chlorpromazine seems to produce its greatest reduction in the rewarding effect may explain why it sometimes causes patients to be depressed. It is conceivable that the patients who are helped are the ones who have far too strong a striving for certain unrealistic or tabooed rewarding goals.

The striking differences in the patterns produced by these two drugs show that the technique has discriminating power. We hope that it will be useful in analysis of the effects of drugs on different motivational systems in the brain and in the search for new drugs which have therapeutic effects in certain kinds of mental illness. Additional techniques for studying the effects of drugs on motivation are described elsewhere (*6*, *24*).

Aggression and Sex

As originally reported by Hess (*13*), stimulation in certain regions of the hypothalamus of cats can produce a spectacular attack response which often is not stereotyped but is flexibly directed at suitable targets. Figure 15 shows an attack response we obtained when stimulating a cat. Prior to such stimulation the cat had ignored the toy dog thrust into the apparatus. When the appearance of the dog was paired with electrical stimulation, the cat attacked the dog. After a number of such trials, a similar conditioned attack was elicited without electrical stimulation.

This beautiful experiment has one flaw, however—subsequent histology showed that the electrode was completely outside the brain, so that the rage must have been elicited by peripheral pain from stimulation of tissues below the brain. Nevertheless, the cat serves as a control to show that aggression elicited by peripheral pain can be conditioned. To date, Roberts has failed to condition a number of cats showing similar attack patterns elicited by stimulation of the hypothalamus. This negative result confirms earlier reports by Masserman (*25*). We are continuing to search, nevertheless, for new areas and techniques which may elicit rage responses that are more like the normal motivation in that they can be conditioned.

Finally, we have observed ejaculations elicited by repetitive stimulation at a number of points in the rat's brain, especially from a point in the medial forebrain bundle near the fornix, which also produces the paradoxical combination of rewarding and punishing effects. Milton Trapold is studying the relationship of these reactions to normal sexual behavior. For example, will electrically induced ejaculation have the same effect on subsequent sexual behavior as would complete satiation by normal means? Such studies may help to tell us whether sexual motivation is relatively unitary in character or is made up of a number of components which can be independently elicited and satiated by electrical stimulation of different parts of the brain.

References and Notes

1. This article is the report of the work of a group at our laboratory. In addition to the students and coworkers cited, Arlo K. Myers made many ingenious contributions to the apparatus involved, Judith B. Levine performed the histology, Burton S. Rosner served as an expert consultant on histology, Ruth Bartlett implanted electrodes in the brains of rats, and colleagues in other departments gave useful advice. The studies reported in this article were supported for the most part by a research grant, M647, from the National Institute of Mental Health of the National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare, Bethesda, Md. Grants-in-aid money from the Behavioral Sciences Program of the Ford Foundation was of unique value in certain critical phases of the resarch because it could serve as an immediately available, fluid, unrestricted reserve.
2. In order that the students working on the experiments should be given maximum credit, their names are cited in the article, but in some cases the reference number given may be that of the article in which the results are summarized and hence may have a different author. More complete reports are planned in a forthcoming book.
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Alan Gregg, Physician

On the 19th of last June, Alan Gregg died. A great statesman in his every field of endeavor, he was highly respected in all countries where concepts of health are in harmony with available knowledge. He was beloved not only for the material assistance provided through his representations, not only for his understanding of every individual whose problems came to his attention—and many there were—but especially for his kindly consideration of everyone, great or small, wise or otherwise. This resulted in influences that will continue inevitably and will bring to Alan Gregg a distinction, in his immortality, such as any sincere and able man might covet.

This man Gregg, in the sense of Anthony's speech, cannot be categorized. The attempt would emphasize single attributes or activities. As important as specialization is, it all too often narrows the perspective, quite contrary to the expanding vision that was so characteristic of Gregg. When he received the highly merited Lasker Award a few months ago, it was said of him, "a physician who hasn't treated a patient in thirty-five years, a medical educator who has never taught a class, a research man who has done no research, yet—he accomplished more for medical research, medical education, and the practice of medicine than if he had been personally outstanding in all three." This is well said; yet what are vision of need, plans for fulfillment, and support of venture—all characteristic of Gregg's life work—if they are not research, education and practice in the broader sense?

How he chose medicine as a career is told by Gregg in *Our Anabasis,* an address made in 1954 to the Association of American Physicians. As is often the case, his own childhood illness and his family doctor's care (as much for the parents as for the patient)—care that involved less knowledge of the sore throat and more of the psychology of all concerned—were determining. Read this account. Any effort to convey the essence of Gregg's narrative would fall short of his own depth of expression. There are other fundamentals in this address that aid in an understanding of this vital person. They include his intellectual maturation; his evaluation of knowledge acquired independently; the relative importance of knowledge for its own sake; and the process of arriving at the realization that medicine is not omnipotent and that all too often the result is not cure but, as he put it, "M.D.—Make Do.—Quaint idea! . . . Work for the handicapped . . . who is handicapped, your patients, or you? Both. Helping the survival of the unfit. . . . With more to come. What in the world was the solution. Where to find a formula for head and heart too?"

The necessity of earning money for his education delayed Alan Gregg's entrance into medical school by a year, but the experience was a maturing one, and he never regretted it. This was in 1912, and the scientific renaissance of medicine in the United States was well under way, at the expense of the art that had been so impressed on Alan, as a sick child, by his doctor. His interest in prevention, as distinct from treatment, of disease was soon kindled. So there was no hesitancy on his part at the end of his military service, in 1919, in accepting an opportunity to serve on the International Health Board of the Rockefeller Foundation. It will not be forgotten, even in this time of affluence, that this foundation is one of the group of great philanthropies of the Rockefeller family, which include the Institute, the General Education Board, and the Laura Spellman Rockefeller Fund. It has been more responsible, no doubt, than all other influences for the advance of medical education and research from a very inferior stage to their present high position.

Gregg remained part of this great scheme of things throughout his professional life. Early assignments in South America, and then Europe, provided years of unparalleled opportunity. He emerged without doubt the best informed individual in the field on institutions for medical education and for research, and on their resources, including, particularly, personnel.

It was my privilege to benefit from Gregg's wide information in 1929, when scientists were being sought for the exploration of problems of human behavior. This was no less than 4 years before the Rockefeller Foundation approved psychiatry as a major concern of the Division of Medical Sciences—a decision in large part due to Gregg's interest in this important area of health. My conferences with him were helpful, and the weeks of travel and exploration that followed were largely based on his advice. My impression has grown to conviction, as the years have slipped by, that Alan Gregg was one of the few who appreciated the need for, and the potentialities of, the application of science to behavior. Certainly his influence has played a major role in present-day interest in, and understanding of, mental health.

Gregg's attention to behavior was not confining. He was alert to improvement in the pattern of approach to any health project, and it is not surprising that he supported the eager and sincere effort for basic understanding of the life history of the tooth in its relation to prevention of disease. Progress in this important subject must, in no small part, be credited to Gregg.

These examples—mental and dental health—are evidences of Gregg's inherent ability to discern problems not adequately under study on the widening horizons of health; his contributions remain as significant mileposts.

Alan Gregg's unusual adaptability came into evidence strongly in the last 5 years of his life. His assistance was in demand by many agencies concerned with the national emergency, so he withdrew, before his scheduled retirement, as vice president of the Rockefeller Foundation. It was my privilege to work with him on several committees, including those of the National Research Council in its associations with the Atomic Energy Commission, the Health Advisory Committee of the Office of Defense Mobilization, and the medical task force of the Second Hoover Commission. Again, and even more forcibly, Gregg's understanding of men from many of life's highways and byways, his capacity for objective analysis of problems, his suggestions for their solutions, and his extraordinary capacity to present the case for sympathetic consideration, made him outstanding.

Needless to say Alan Gregg was a busy man. There was scant opportunity for him to enjoy home and family, of whom he always spoke with a ring in his voice and a light in his eye that allowed no other interpretation than happiness.

It has been well said: "Better worlds are born, not made, and their birthdays are the birthdays of men." Alan Gregg was such a man.

M. C. WINTERNITZ

Washington, D.C.

News of Science

Security System Hit

A past president of the AAAS spoke about the political abuse of the government's personnel security system at a meeting of the American Physical Society on 29 November in St. Louis, Mo. Edward U. Condon, who at present is professor of physics at Washington University in St. Louis, drew largely upon his own experience. An excerpt of his address follows.

"During the last two months there has come about a general public awareness that America is not automatically, and effortlessly, and unquestionably the leader of the world in science and technology. This comes as no surprise to those of us who have watched and tried to warn against the steady deterioration in the teaching of science and mathematics in the schools for the past quarter century. It comes as no surprise to those who have known of dozens of cases of scientists who have been hounded out of jobs by silly disloyalty charges, and kept out of all professional employment by widespread blacklisting practices. It comes as no surprise to those of us who have known how good American scientists have had to face vilification by political speechmakers in and out of Congress, and have been falsely prosecuted for perjury, and have been improperly denied passports, or have had their passports seized and invalidated without due process by the State Department, or who have had their telephones tapped or their letters intercepted by government agents. . . .

"I do not wish to seem boastful, and in this respect I would gladly change places with any of you, but I think that I have probably had a bigger dose of this kind of mistreatment than any of my fellow members of the American Physical Society. It began ten years ago last summer.

"In that time I have had two full-scale loyalty hearings in the Department of Commerce, a full field investigation for the Atomic Energy Commission, which occupied the efforts of 300 FBI agents, and finally in 1954 had a hearing under the policies and procedures set up by this Administration. In all of these I received full clearance. All covered essentially the same ground, which was no ground at all. The House Committee on Un-American Activities made numerous attacks on me in 1947 and 1948 before its then chairman went off to serve a term in a federal penitentiary. . . . Finally this committee staged a political hearing on the same old stale and outworn material just before the 1952 elections.

"During most of this period I kept on working to develop the scientific strength and stature of the National Bureau of Standards. Happily this work is being carried on by my successor in spite of his having been summarily fired for a time by the present Secretary of Commerce who wanted the free play of the market place to take precedence over careful scientific experimentation.

"Edward Teller told this last personnel security board hearing in April 1954 that the bureau's work on the hydrogen bomb which I organized advanced our achievement of that goal by many months, probably a year. If he is correct in the implication that without that work we would have been delayed by about a year, then the lack of that work would have made us come in second in the international rivalry for the hydrogen bomb.

"Nevertheless, all the old stuff was rehashed once in 1952 and again in 1954. I was badgered all those years for having been interested in the American-Soviet Science Society, an organization which received a grant from the Rockefeller Foundation ten years ago to foster translation and wider distribution in this country of the Russian scientific literature. Now, a decade late, we read of crash programs to translate the Russian scientific literature and spread it around in this country. . . .

"In July 1954 I was given complete security clearance by the Eastern Industrial Personnel Security Board. You might think now that I would be allowed to go back to work. Yet in October 1954, just before the elections, we find Nixon . . . boasting that he got the Secretary of the Navy to suspend my clearance, as was done on October 21.

"It was arbitrarily suspended without any pretense that additional evidence needed to be considered. It was suspended by a Secretary of the Navy who admitted that he had not seen the record. I was told that I would have to go through the same old dreary business again. Three years ago I faced a very difficult decision—whether to continue to fight for the Government's honor, or whether to yield to the Administration's determination to disgrace itself. . . .

"You might think that now I would be allowed to go back to work. I came East in January 1955 after giving my retiring presidential address to the American Association for the Advancement of Science and was offered the post of chairman of the department of physics in a leading university. In March the chancellor of that university told me that he could not follow through on the appointment because a high government official threatened one of the university trustees that if my appointment went through, that university would lose all of its Federal funds.

"In June of 1955 I was asked to serve on a committee on a nonclassified problem of military importance—and then suddenly asked not to, just before the first meeting of that committee.

"Incidentally I *was* cleared from July 1954 to October 1954. During that period some navy people came to see me with an urgent problem on the development of a radome for a guided missile. It was highly secret, but I was cleared for it. By the time we had the development models made my clearance had been suspended 'pending further consideration,' as Secretary [of the Navy] Thomas put it. Some of our cleared young men tried to deliver the radomes but found these navy men in such a state of panic that they would not accept them! A few weeks later—all this was just about three years ago—they regained their courage and sheepishly asked to have the radomes. They were tested and found to be good and are now in production. Detail problems about them come up from time to time, but I am not allowed to help in their solution. . . ."

Shippingport Reactor Starts

The central station atomic power plant at Shippingport, Pa., was started on 2 December, the 15th anniversary of the first self-sustaining nuclear fission in the reactor at the University of Chicago. The Westinghouse Electric Corporation designed and constructed the nuclear portions of the plant under contract with the Atomic Energy Commission, and contributed $500,000 toward its cost. The Duquesne Light Company contributed $5 million toward the expenses of the nuclear portion of the reactor and

constructed, at its own expense, the turbine generator portion. The rest of the cost—$50 million—was borne by the AEC. The Duquesne Light Company will operate the plant for the Atomic Energy Commission.

The pressurized water reactor plant uses ordinary water to moderate the nuclear fission process; the water, under pressure, is circulated through the reactor core to remove heat produced by the atomic fission. The hot water is then pumped through heat exchangers in which steam is produced which will be used, when the reactor plant is in full operation, to power a steam turbine that will provide electricity.

During the initial start-up test, the reactor operated at a power level of about 25 kilowatts of heat. No electricity was generated. In the course of the last 3 weeks numerous tests have been made to determine the nuclear characteristics of the reactor and to test satisfactory operation of the reactor components. When these tests have been completed, the power level of the reactor will be increased gradually. At full power the plant is expected to produce 60,000 kilowatts of electricity which will flow into the system of the Duquesne Light Company.

The reactor core contains 14 tons of natural uranium in the form of a "blanket" surrounding some 165 pounds of highly enriched uranium. There are 32 enriched uranium fuel elements, each with its own control rod, and 113 natural uranium elements in the core. The 32 control rods regulate the nuclear fission or heat producing process. They are made of hafnium metal, which was selected because it readily absorbs neutrons and thus affords accurate regulation of the fission process.

United States, Britain, and Fusion Power

It has been reported that Britain has made a major advance toward the peaceful use of fusion power. But nuclear authorities and members of the government so far have refused to confirm this report. A recent issue of the British newspaper, the *Manchester Guardian,* included the following statements in a front-page story.

"The publication of details of Harwell's most recent successes in thermonuclear research is being held up in response to United States representations. . . . It is being suggested that the United States Atomic Energy Commission is unwilling to stomach publicity for a resounding British achievement at a time when its own reputation in the United States is steadily declining. . . .

"It is only fair to add that collaboration between Britain and the United States in the particular field is close and apparently effective. . . . As a result of this collaboration United States scientists can expect to take some of the credit for the success of the British research."

The United States and Britain exchange information on their work in fusion power, and they are therefore both governed by the same declassification guide; together they decide what is to be published and what is to remain secret. The guide is reviewed periodically and it was last reviewed in June. Any new review will have to be ratified by both countries before information is released by either. Confirmation of an H-power development might depend in this sense on U.S. agreement.

The United Kingdom Atomic Energy Authority, advised by Sir John Cockcroft, head of the Harwell Research Institute, has stated that neutrons have been produced at very high temperatures, that they probably are the result of the fusion of atoms, but that just possibly they may have been produced by other means.

Nordic Institute

The five Nordic countries have set up an organization to strengthen cooperation in nuclear physics. One of the main objectives of the organization is the establishment of the Nordisk Institut for Teoretisk Atomfysik (Nordic Institute for Theoretical Atomic Physics) in Copenhagen in a building which will be erected by the Danish Government in connection with the existing premises of the Institute for Theoretical Physics of the University of Copenhagen. Among the further activities planned are exchange of Nordic scientists, organization of symposia, and visits of scientists from other countries to Scandinavian physical institutions.

The Nordic Institute will provide facilities for a number of younger physicists from the member states so that they may receive advanced training in theoretical nuclear physics. In addition, the institute will serve as a gathering place for physicists from Scandinavian and other countries.

The new organization is governed by a board composed of theoretical physicists delegated by the five countries. Niels Bohr has been elected the first chairman of the board.

Until a formal agreement has been established by the participating governments, the organization is functioning on an interim basis. The Nordic Institute started its activities on 1 October, using facilities provided by the Copenhagen Institute for Theoretical Physics. For the interim period C. Møller has been appointed director of the institute (during his absence on a visit to the United States, T. Gustafson is acting director), assisted by G. Källén, B. Mottelson, and S. Rozental. On 1 February, L. Rosenfeld will join the staff of the institute as a permanent member.

STIP Interagency News Letter

The fifth semiannual Interagency News Letter prepared by the AAAS Science Teaching Improvement Program was issued on 1 November. The News Letter is a direct result of a resolution adopted by the October 1955 Conference on Improvement of Science Teaching, sponsored jointly by the National Science Foundation and the AAAS. This resolution called on the AAAS to investigate the possibility of publishing a news letter reporting the activities of various professional organizations and governmental agencies in regard to the improvement of the teaching of science and mathematics and to the recruitment of additional personnel in these fields. The first of these news letters appeared in April 1956.

In the current issue of the News Letter an attempt has been made to condense the report of each organization in order to reduce the bulk and expense of the final product. Special emphasis has been placed on new projects not previously listed and on progress reports. The report is for the most part restricted to the activities of the national professional societies, except in certain cases where programs of special importance are involved. Twenty-five separate reports are included.

A limited number of single copies are available. Requests should be directed to the assistant director of STIP, J. R. C. Brown, AAAS, 1515 Massachusetts Ave., Washington 5, D.C.

Papers for International Nuclear Congress

The Atomic Energy Commission invites scientists to contribute papers to the Second International Conference on the Peaceful Uses of Atomic Energy (Geneva, Switzerland, 1–13 September 1958). Abstracts of not more than 500 words should be mailed by *1 January* to the Technical Director, Office for International Conference, 736 Jackson Place, NW, Washington 25, D.C.

Special AEC panels will review all abstracts. Those accepted will be forwarded to the United Nations secretary-general for the conference for final review and, if selected, will be included in the agenda. Complete procedures for

preparing and submitting abstracts and final papers, as well as the conference agenda, will be furnished on request by the technical director.

Library of Science Program for Young Adults

The Library of Science, New York, comprising some 40,000 scientists, educators, and related professionals, has started a new program for gifted and science-minded young people of high school age. The new Young Adults' Division will endeavor to bring to young people—on their own level—the type of reading material the Library of Science provides for its regular members.

The stimulus for the new program came from the members of the Library of Science who responded to an initial test mailing by enrolling more than 3000 charter members in the Young Adults' Division. Membership is now open to all young people of high school age who are sponsored by their parents or other adults.

New Antenna at Illinois

An antenna reflector 28 feet in diameter has been erected on top of the Electrical Engineering Building at the University of Illinois to receive signals coming by way of the moon from the Signal Corps Laboratory at Ft. Monmouth, N.J. A possible application would be to use the moon to reflect television signals from any point where the moon is visible to any other point. Another would be to reflect control signals from the moon to guide a rocket part way around the curvature of the earth, or start it on a path going even farther. In the process, dispersal of energy is tremendous: of 40,000 watts transmitted from New Jersey, only about 100 reach the moon, and one-millionth of one-billionth of one watt is received back in Urbana-Champaign.

Grants, Fellowships, and Awards

Bacteriology. The $1000 Eli Lilly Award, which is given annually to a microbiologist, will be awarded to a person who is less than 35 years of age on 30 April 1958 and who has performed outstanding research in bacteriology or its related fields. The award committee is composed of representatives of the Society of American Bacteriologists, the American Association of Immunologists, and the American Society for Experimental Pathology. Nominations should be sent before 15 January to Dr. Arthur Kornberg, Department of Microbiology, Washington University School of Medicine, Euclid Avenue and Kingshighway, St. Louis, Mo.

Genetics. The André Dreyfus Foundation, Rio de Janeiro, Brazil, invites applications for its International Genetics Prize of 150,000 cruzeiros. The award is intended to support the development of research programs, travel for purposes of research, or publication of research results. Applicants should submit a *curriculum vitae,* a list of publications, and a detailed plan of the research program proposed or a copy of the manuscript being offered for publication. Applications and supporting documents must be received before 31 January by Jenny Dreyfus, Secretária Geral da Fundação-Prêmio André Dreyfus, Rua Belfort Roxo 40, apto. 502–Copacabana, Rio de Janeiro, D.F., Brazil.

Gerontology. The Inter-University Training Institute in Social Gerontology of the University of Michigan has announced 35 faculty fellowships for a summer training seminar in social gerontology to be held at the University of Connecticut, 4–29 August. The awards are open to college faculty members who are trained in one of the social sciences and who are actively interested in developing programs in social gerontology at their institutions. The stipend is $500; travel costs and living accommodations on the university campus are also paid. For information, write to Dr. Wilma Donahue, Director, Institute for Social Gerontology, 1510 Rackham Building, University of Michigan, Ann Arbor, Mich.

Librarianship. The Medical Library Association will award eight scholarships of $150 each to students accepted for the approved courses in medical librarianship during the summer sessions of the following institutions: School of Library Service, Columbia University; Division of Librarianship, Emory University; University of Illinois Library School; and the School of Library Service, University of Southern California. Applications for scholarships should be made to the library school at the time of application for enrollment. Sufficient time should be allowed for the school to pass upon credentials and forward applications for scholarships to the Medical Library Association. The association's closing date is 1 March, and candidates must have been accepted for admission by the library school.

Mechanics of Fluids. The Humanities Fund, Inc., New York, has announced the $3000 Boris A. Bakhmeteff graduate fellowship for the support of research of an original and creative nature in the general field of mechanics of fluids. For information, write to Dean William Allan, School of Technology, City College of New York, New York 31, N.Y., who must receive completed application forms by 15 February.

Ophthalmology. The National Council to Combat Blindness is accepting applications for its 1958–59 Fight for Sight grants-in-aid, research fellowships, and summer student fellowships. Application forms, which must be submitted by 1 March, may be obtained from the Secretary, National Council to Combat Blindness, Inc., 41 W. 57 St., New York 19, N.Y.

Psychiatry. The Society of Biological Psychiatry is offering an annual award that has been made possible by the A. E. Bennett Neuropsychiatric Research Foundation. The award consists of traveling expenses to the society's annual meeting, expenses at the meeting, and an honorarium of $250; it will be given to a young investigator for an unpublished report of recent research. Papers should be sent in quadruplicate to Arthur A. Ward, Division of Neurosurgery, School of Medicine, University of Washington, Seattle 5, Wash.

Psychometrics. The Educational Testing Service has announced two research fellowships in psychometrics leading to the Ph.D. degree at Princeton University. The stipend is $2650. Undergraduate preparation may consist of a major in psychology with supporting work in mathematics or a major in mathematics with some work in psychology. A candidate must either have taken the Graduate Record Examinations in 1957 or register by 3 January to take these examinations on 18 January. Fellowship applications must be received before 3 January by the Director, Psychometric Fellowship Program, Educational Testing Service, 20 Nassau St., Princeton, N.J.

Secondary School Teaching. The Shell Companies Foundation, Inc., has announced that fellowships will be provided for special study next summer to 100 high school teachers of physics, chemistry, and mathematics. Half the recipients will attend summer sessions at Stanford University, and half will go to the Cornell University. Fellowship teachers receive allowances for travel, tuition, living expenses, and $500 in cash to offset the loss of other summer earnings. Teachers in the United States and Canada with 5 years' experience and known leadership ability are eligible. Applications should be sent before 1 February to the two universities. Teachers living west of the Mississippi River should write the School of Education, Stanford University, Stanford, Calif. Teachers living east of the Mississippi should write the School of Education, Cornell University, Ithaca, N.Y.

Statistics. The department of statistics at the University of Chicago has established a program of postdoctoral awards

in statistics under a grant from the Rockefeller Foundation. The awards, which range from $3600 to $5000, are intended for investigators whose primary field is not statistics but one of the physical, biological, or social sciences to which statistics can be applied. The closing date for application is 15 February. For information, write to the Department of Statistics, Eckhart Hall, University of Chicago, Chicago 37, Ill.

Therapy. The American Therapeutic Society is accepting nominations for the Oscar B. Hunter memorial award, which is given annually to recognize an outstanding contribution, or series of contributions, to therapy by an individual or by a team of workers. The term *therapy* is used in a broad sense to include the use of any drugs, procedure, or device of benefit in the treatment of patients. Nominations must be submitted before 1 February to the chairman of the award committee, Dr. Harry E. Underleider, 393 7th Ave., New York 1, N.Y.

Cancer Advisers

A Board of Scientific Counselors has been established by the Public Health Service to review, discuss, and make recommendations concerning the research conducted by the National Cancer Institute at the National Institutes of Health, Bethesda, Maryland, and in the field.

The new board is composed of the following nongovernment scientists: Wendell M. Stanley, Nobel prize winner and director of the Virus Laboratory, University of California, Berkeley, chairman; Charles Huggins, professor of surgery, University of Chicago; E. K. Marshall, emeritus professor of pharmacology, Johns Hopkins University; Carl V. Moore, professor of medicine, Washington University; Eugene P. Pendergrass, professor of radiology, University of Pennsylvania; and Philip P. Cohen, professor of physiological chemistry, University of Wisconsin.

New York Academy of Sciences

The year ending 31 October was the most successful in the 141-year history of the New York Academy of Sciences, according to the institution's annual report. The report described 15 special conferences, attended by 6700 scientists from most sections of the world, and 123 regular meetings on a variety of subjects ranging from electron diffraction to astrophysics to cancer. Fifty-six other societies also held 312 meetings at the academy during the year.

Publication of transcripts of meetings and conferences, and of programs, was an important part of the academy's activities: 23 monographs, totaling 4601 pages, recorded 391 papers by 653 authors. Academy transactions accounted for 770 additional pages of type. Thirty-one volumes, in all, were published.

Though sale of publications was a major source of income for the academy, it was second to membership fees. The academy had a net increase in membership of 1869 during the year. Members are concentrated in the New York area, but also represent all 48 states, four U.S. possessions, and 65 foreign countries.

News Briefs

Britain and France have agreed to link their electric power systems by means of a cross-channel cable system. The project is expected to be completed by the winter of 1960–61. The total annual saving for the two countries is estimated at £300,000 ($840,000). The two countries will actually gain further because they will not have to provide additional facilities to meet daily and seasonal peak demands. The times of these demands are different for each country.

* * *

An extension to Britain's Radiochemical Center at Amersham, Buckinghamshire, was recently opened to enable the center to meet the demand for its radioactive products, about 70 percent of which are exported. The improved facilities are expected to make the scale of radioactive operations about 100 times greater than before.

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Irenee duPont of Wilmington, Del., has given $35,000 to Dickinson College to equip and furnish a science library in the $650,000 C. Scott Althouse Science Building that is now under construction on the campus and scheduled for completion next August.

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The Lincoln Laboratory of Massachusetts Institute of Technology in Lexington, Mass., has announced the completion, on Millstone Hill in Westford, Mass., of a very large and high-powered long-range radar. Lincoln Laboratory is engaged in electronic research on new problems of air defense and is supported by the Army, Navy, and Air Force.

* * *

Childbearing is now safer than ever before, according to the Metropolitan Life Insurance Company. In 1956, when registered births in the United States reached a record high of 4,168,000, fewer than 1600 deaths due to complications of pregnancy and childbirth were reported. The 1956 maternal mortality rate of 3.8 per 10,000 live births represents a reduction of about one-half in the last 5 years, and of about three-fourths in the last decade.

* * *

A new $10-million United Engineering Center is to be erected on United Nations Plaza in New York to replace the present Engineering Societies Building at 29 W. 39th St. The 22-story structure, which is to be occupied in the fall of 1960, will serve as the headquarters of 16 national engineering societies with a total membership of about one-quarter of a million engineers.

* * *

Fourteen leading engineering figures will act as sponsors for the 1958 National Engineers' Week, 16–22 February. The week is under the general direction of the National Society of Professional Engineers. The group of leaders includes James R. Killian, Jr., president of Massachusetts Institute of Technology and newly appointed special assistant to President Eisenhower for science and technology.

* * *

The Maritime Administration, U.S. Department of Commerce, and the Atomic Energy Commission have awarded a contract for the construction of a nuclear powered merchant ship, the *Savannah,* to the New York Shipbuilding Corporation of Camden, N.J. The ship's nuclear propulsion system will be furnished by the Babcock and Wilcox Company under a separate AEC contract.

* * *

The Armed Services Technical Information Agency, with headquarters in Dayton, Ohio, has announced the opening of the ASTIA San Francisco Regional Office in the Oakland Army Terminal. The new office is designed to furnish technical report services and assistance to Department of Defense supported research and engineering activities in the San Francisco region, including northern California and the bordering states.

Scientists in the News

WARREN WEAVER, vice president for natural and medical sciences of the Rockefeller Foundation, and AAAS president in 1954, has received the Public Welfare Medal of the National Academy of Sciences. The medal is awarded for outstanding public service in the uses of science rather than for achievements within a particular scientific discipline.

LARS ONSAGER, J. Willard Gibbs professor of theoretical chemistry at Yale University, has been selected to receive the Lorentz Medal of the Royal Netherlands Academy of Sciences. The

medal, which has been given six times since it was first awarded in 1957, will be presented to Onsager on 7 May in Amsterdam during the academy's 150-year anniversary celebration.

PAUL P. WEINSTEIN of the National Institutes of Health, Bethesda, Md., has received the Bailey K. Ashford Medal of the American Society of Tropical Medicine and Hygiene.

RONALD P. BELL, university reader in physical chemistry and fellow of Balliol College, Oxford, England, will deliver the Baker lectures in chemistry at Cornell University beginning in February 1958. He will speak on "The proton in chemistry."

ERNEST A. MARTINELLI, former head of the nuclear physics department at Aeroneutronics Systems, Inc. (1956–57), has joined the Rand Corporation, Santa Monica, Calif., as a member of the theoretical physics staff. From 1950 to 1956 Martinelli was on the staff of the University of California Radiation Laboratory at Livermore and Berkeley.

Beginning with the 1957–58 academic year, Tuskegee Institute is offering a major in biology. JAMES H. M. HENDERSON has been named head of the department of biology. He was professor of biology in the School of Agriculture before Tuskegee's recent reorganization, and he continues as a research associate at the Carver Foundation.

R. L. KYHL and H. F. WEBSTER of the Research Laboratory, General Electric Company, Schenectady, N.Y., will receive the 1958 W. R. G. Baker Award of the Institute of Radio Engineers for their paper on the "Breakup of Hollow Cylindrical Electron Beams" that appeared in the October 1956 issue of *IRE Transactions on Electron Devices*. The award is given annually to the authors of the best paper published in the transactions of the IRE professional groups.

ARTHUR KARP of Bell Telephone Laboratories, Inc., Holmdel, N.J., has been named recipient of the 1958 Browder J. Thompson Memorial Prize Award for his paper on "Backward-Wave Oscillator Experiments at 100 to 200 Kilomegacycles" that appeared in the April 1957 issue of *Proceedings of the IRE*. The Thompson award is given annually to an author under 30 years of age for a paper recently published by the IRE which constitutes the best combination of technical contribution and presentation of the subject. Both awards will be presented at the annual IRE banquet on 26 March 1958 at the Waldorf-Astoria Hotel in New York during the institute's 1958 national convention.

The following Russian medical scientists have arrived for a month's stay in the United States. ZOIA DOROFEEVA and NINA ZHDANOVA, heart specialists, will study cardiology and cardiac rehabilitation with Paul Dudley White of Boston, Mass., and Ancel B. Keys of Minneapolis, Minn. NIKOLAI VIAZEMSKI, psychiatrist, and DMITRI LUNEV, a neurologist, will spend their time with Howard A. Rusk, director of Physical Medicine and Rehabilitation at New York University–Bellevue Medical Center.

ROGER H. CHARLIER, until recently chairman of the department of geology and geography at Hofstra College, is leaving this month for Paris, where he will be a visiting faculty member in the department of marine and submarine geology for the period January–July 1958. He is on leave of absence from Hofstra.

JAMES A. REYNIERS, director of the Lobund Institute, University of Notre Dame, received the second Griffin Award during the recent annual meeting of the Animal Care Panel. The award is presented to the individual who has most significantly advanced the concept of improved laboratory animal quality.

RALPH T. ESTERQUEST, director and secretary of the Midwest Inter-Library Center and Corporation of Chicago, will become librarian of the Harvard Medical School, School of Dental Medicine, and School of Public Health on 1 January. Esterquest will also be a member of the faculties of medicine and public health at Harvard. The Medical Area Library is a division of the Harvard University Library.

Esterquest's appointment is the initial step in a program of reorganization and expansion of the Medical Area Library which will strengthen its role in the teaching and research activities of the three schools.

PAUL S. GRANVILLE, physicist in the Navy's David Taylor Model Basin, Washington, D.C., was awarded the Captain Joseph H. Linnard Prize by the Society of Naval Architects and Marine Engineers for the best paper contributed to the proceedings of the society during 1956. He was honored for his work on "The Viscous Resistance of Surface Vessels and the Skin Friction of Flat Plates."

CHANDLER A. STETSON, JR., has been named professor and chairman of the department of pathology at the New York University College of Medicine. The appointment will become effective at the close of the 1957–58 academic year, when LEWIS THOMAS, the present incumbent of the chair, becomes chairman of the department of medicine.

Recent Deaths

N. P. ANDERSON, Los Angeles, Calif.; 58; president of the American Academy of Dermatology; 2 December.

MAURICE BRUGER, New York, N.Y.; 53; director of the department of clinical pathology and chief of the thyroid clinic at University Hospital of New York University–Bellevue Medical Center, and associate professor of medicine at the center's Post-Graduate Medical School; specialist in metabolic diseases; 26 November.

JAMES M. CORK, Ann Arbor, Mich.; 63; professor of physics at the University of Michigan and a member of the department of physics since 1920; an early researcher with particle accelerators who had gained an international reputation for extensive studies of x-rays, radioactivity, and atomic structure; 20 November.

OSBERT CRAWFORD, Southampton, England; 71; pioneer in the use of aerial photography for archeological research; 29 November.

WILLIAM EASBY, JR., Philadelphia, Pa.; 95; retired civil engineering professor at the University of Pennsylvania; 2 December.

JOHN J. FRANK, Pittsfield, Mass.; 84; a retired electrical engineer who held more than 40 patents for improvements in transformer design; member of the staff of the General Electric Company, Schenectady, N.Y., from 1894 to 1932; 28 November.

ANDREW HECHT, New York, N.Y.; 54; head of Bonus Books, publishers of soft-cover medical books; 2 December.

J. K. PLUMMER, Atlanta, Ga.; 71; director of the Tennessee Corporation, College Park, Ga., and its manager for 37 years; pioneer in promotion of use of trace elements in agriculture; 10 November.

DOMINGO ROSILLO, Havana, Cuba; 81; aviation pioneer in Cuba; made the first flight between Cuba and the United States; 28 November.

MANFRED J. SAKEL, New York, N.Y.; 57; pioneer in psychiatry and originator of insulin shock therapy for schizophrenia; 2 December.

THOMAS D. SPEIDEL, Minneapolis, Minn.; 49; head of the division of orthodontics at University of Minnesota School of Dentistry; 1 December.

EUGENE L. SWAN, Boston, Mass.; 82; child psychiatrist and pioneer in boys' camping work; 2 December.

ABBY HOWE TURNER, South Hadley, Mass.; 82; professor emeritus and first chairman of the physiology department of Mount Holyoke College; 26 November.

DELMAR YOUNG, Port Washington, N.Y.; 48; professor of dairying at the University of Delaware; 28 November.

Reports

Source and Deposition of Clay Minerals in Peorian Loess

Loess is one of the most remarkable of the Pleistocene deposits. It is associated with and covers to varying depths and extent most of the major sheets of glacial drift. The origin of loess, however, has been debated. Scheidig (*1*) lists some 20 hypotheses that have been advanced at one time or another to explain its presence and distribution. Chamberlain (*2*) has advanced the most widely accepted theory to explain the origin of loess in the upper Mississippi Valley. He considered the loess as a wind deposit emanating from the flood plains of the major Pleistocene rivers. His concept was that proloess materials were deposited from glacial melt waters on the flood plains of the rivers. After drying, these materials were picked up by strong winds and redeposited as loess on the adjacent uplands.

Chamberlain's theory implies that the mineralogy of the unaltered loess and that of the associated unaltered tills should be similar, including the clay minerals. Studies of clay minerals (*3–5*), however, have shown that the principal type of clay in calcareous Peorian loess in Illinois, Kansas, Nebraska, Iowa, and Missouri is montmorillonite, whereas, illite and some chlorite are the principal clay minerals in tills of Wisconsin age over a broad area (*3, 6, 7*). Some explanations given to account for this difference in mineralogy follow: (i) the montmorillonite clay now found in Peorian loess resulted from weathering of the illite and chlorite in the calcareous material after deposition; (ii) the clay and silt minerals of Wisconsin age weathered to form montmorillonite before and/or during transport; and (iii) the montmorillonite was differentially picked up by the silt particles from the river flood plains, thus concentrating this type of clay in Peorian loess.

On the basis of studies of clay mineral in soils developed entirely from tills of Wisconsin age, explanations i and ii above were considered unlikely. For instance, Beavers *et al.* (*3*) found that only small amounts of montmorillonite (maximum 10 percent) had formed in soils developed from Tazewell and Cary age tills and that no montmorillonite had formed in calcareous tills of the same age. Similar results were found by Bidwell and Page (*6*). Explanation iii cannot be ruled out, although I believe that the bulk of the sediments carried by the Illinois and Wabash rivers during the time of deposition of Peorian loess were of Wisconsin age and that illite was the principal clay mineral in the sediments. The influence of local flood-plain clay sediments is indicated by the tendency of illite clay to concentrate in calcareous Peorian loess in Illinois (5 to 20 percent) near the major rivers (*3, 5*).

I postulate that the bulk of the clay minerals in Peorian loess did not come from local flood plains but that these minerals were carried in by strong winds from widely scattered sources throughout the central United States. The problem is essentially one of deposition of the fine clay. I suggest the following as a possible mechanism that may account for the deposition of fine clays carried from afar, along with local flood plain silts. The air-borne clay minerals were electrostatically attracted and adsorbed onto the larger silt-sized particles that were blown from local flood plains, and then the clays and silts were deposited together.

Charge spectrometer studies of quartz and standard clay minerals, as well as of clays and silts from Peorian loess, show that these materials have a tendency to take on strong electrostatic charges (*5*). It is well established that dust storms are highly electrified, the friction of the particles providing a source of electricity. Boning (*8*) advanced the theory that a part of the charge developed in dust clouds was the result of friction between particles of different sizes. That particles of silt and clay minerals have different electrostatic charges is suggested not only by the fact that the two kinds of particles are different in size but also by the fact that their crystalline structure and dielectric properties are different.

Dallavalle (*9*) states: "Fine dust particles may be swept upward by turbulent wind and kept in motion by it so that the effect of gravity is nullified." Even today, Illinois receives clay from western storms that occasionally cause the sun to appear hazy. When these fine air-borne clays are brought down by snow or rain, they fall in sufficient concentrations to cover clean surfaces with buff-colored clay particles. We also know that fine clay-size material from bomb blasts and volcanoes is carried long distances by wind, even across continents and oceans.

A unique property of loess is its unstratified nature. Thin sections of Peorian loess adjacent to the Wabash, Mississippi, and Illinois rivers show that the materials possess a fine porous fabric with the larger silt-sized grains connected with intergranular braces of a light ocher color consisting of very fine silt with clay minerals evenly disseminated throughout. A homogeneous and unstratified deposit would not be expected to result from the normal settling of silts and clays. Here again it appears that some mechanism other than the normal settling forces was operative and that the silt and clay did not settle independently.

The electrostatic adsorption and deposition of fine clay by local flood plain silts could explain the distribution of the montmorillonitic type of clay throughout the Peorian loess area as well as the unstratified nature of the loess deposit.

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12 August 1957

Artifact in Spectrophotometry Caused by Fluorescence

Recent publications (*1*) have called attention to the possible occurrence of artifacts in difference spectra. These false readings, which generally appear as

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

distorted curves with lowered extinctions, were found to occur when readings were made in the presence of backgrounds of high optical density in spectrophotometers which contain single monochromators and which are equipped with sensitive photodetector units. The explanation offered is that, under such conditions, the inherent stray light represents a major portion of the emergent total light (*2*). In attempts to eliminate such errors, recourse was made to a double-monochromator instrument that produces light of greater optical purity.

We should like to report another cause of distorted spectra which occurs in the low ultraviolet region even with double-monochromator spectrophotometers. An example of this type of distortion is illustrated in Fig. 1. Curve *A* is the absorption spectrum of 5×10^{-5} *M* fumarate. Curves *B* and *C* were obtained with the same concentration of fumarate in the presence of 0.4 mg and 2 mg of albumin per milliliter, respectively, read against reference cuvettes containing the same concentration of protein. These curves demonstrate the supression of the fumarate absorption in the region of high background density. The background densities at which distortions occur can be estimated from absorption curves of dilute solutions of protein. Serum albumin at a concentration of 0.1 mg/ml with a 1-cm light path has an optical density of approximately 0.11 at 280 mμ; at 250 mμ there is a minimum density of about 0.05, and at lower wavelengths the density increases rapidly, having a value of 0.2 at 240 mμ, 1.1 at

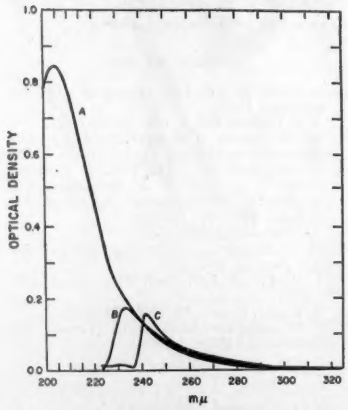

Fig. 1. Effect of protein on the absorption curve of fumarate. Curve *A*, absorption spectrum of 5×10^{-5}*M* fumarate, *p*H 7.4, measured in a model 14 Cary recording spectrophotometer. Curves *B* and *C* are the apparent absorption curves of 5×10^{-5}*M* fumarate in the presence of 0.4 and 2.0 mg of serum albumin per milliliter, respectively.

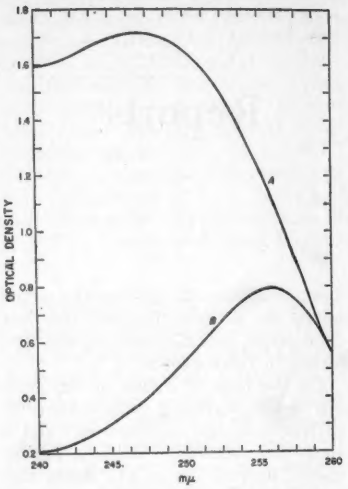

Fig. 2. Fluorescence of silica cuvettes. Five thicknesses of lens paper were placed in the reference beam of a Cary recording spectrophotometer, and the apparent absorption spectrum of a Corning filter No. 7740 was recorded (curve *A*). Curve *B* was then obtained by interposing a silica cuvette between the monochromator and the filter. Placing the cuvette between the filter and the photomultiplier tube did not alter curve *A*.

230 mμ, and 2.0 at 220 mμ. The apparent decreases in optical density at lower wavelengths in curves *B* and *C* of Fig. 1 show the presence of light which is not absorbed by fumarate and which becomes a major component of the emergent light when the background density reaches about 3.

The amount of unselected light reaching the photodetector is far greater than is to be expected from the stray light component of the double monochromator. That this unselected light is caused by fluorescence is demonstrated in Fig. 2. A neutral filter, lens paper, was placed in the reference compartment of the spectrophotometer to simulate a high optical density (approximately 4), and a Pyrex filter was placed in the other compartment. The apparent Pyrex spectrum was recorded (Fig. 2, curve *A*); this curve indicates practically total absorption below 250 mμ. Curve *B* was then obtained by inserting a silica cuvette between the light source and the Pyrex filter. It is apparent that the exciting light has been partially converted by the cuvette to light of a wavelength which penetrates the Pyrex filter. Essentially the same increase in transmission was found when a cuvette containing a high concentration of protein, which absorbs essentially all of the incident light, was interposed between the monochromator and the Pyrex filter. The fluorescent light in this case is produced predominantly by the protein. Protein fluorescence can be demonstrated with cuvettes made of Corning fused silica; these cuvettes yield only traces of fluorescent light when they are irradiated at wavelengths of 240 mμ or higher; when protein is added to such a cell, a large amount of emergent light is found to pass through a Pyrex filter.

The fluorescence of cuvettes in ordinary use is sufficient to cause significant errors in extinctions at wavelengths below 260 mμ in the presence of high background densities. Theoretically, such errors can be avoided in either of two ways: by using nonfluorescing cuvettes or by filtering the emergent beam. In biological experimentation the first alternative is often not adequate, for the background materials frequently used (for example, protein) exhibit high absorbance and fluorescence.

When the samples themselves generate large amounts of fluorescence, the use of monochromators free from stray light does not eliminate artifacts. A second monochromator, when placed between the cell and the photodetector, would serve to eliminate stray light present in the incident beam and, in addition, fluorescence generated in the cuvette. By this device errors due to fluorescence in double monochromators could also be reduced.

Note added in proof: Since submission of this communication, an article by M. V. Buell and R. E. Hansen has appeared (*3*) describing a spectrophotometer using a "solar blind" photomultiplier tube, which does not respond to wavelengths greater than 280 mμ. This device should eliminate artifacts of the type described above except in cases in which light below 280 mμ is emitted by the samples.

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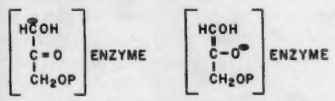
1. A. H. Mehler, *Science* 120, 1043 (1954); I. Fridovich *et al., ibid.* 125, 1141 (1957).
2. The effect of stray light usually encountered is to minimize extinctions, for the materials investigated absorb the selected wavelengths but not the stray light. However, if the absorption spectrum of a compound is low in a selected region of the spectrum and high in the region of stray light, false peaks will be produced when the spectrum is measured over a high background density. This phenomenon has been demonstrated with the enzymatic oxidation product of 3-hydroxyanthranilate, which has a large, broad absorption with a maximum at 360 mμ. In the presence of protein, additional absorption appears in the regions of protein absorption.
3. M. V. Buell and R. E. Hansen, *Science* 126, 842 (1957).

4 September 1957

Spectrophotometric Evidence for Formation of a Dihydroxyacetone Phosphate-Aldolase Complex

Previous studies (*1, 2*) have shown that when dihydroxyacetone phosphate (DHAP) is incubated with muscle, aldolase labilization of a carbon-bound hydrogen occurs. On the basis of this observation the enzyme-DHAP complex was formulated as involving a carbanion or an enediol structure:



It was suspected that such structures would absorb in the ultraviolet region. For example, both dihydroxyacetone and D,L-glyceraldehyde in 1*N* sodium hydroxide show strong absorption in the ultraviolet with maxima at 220 mμ (*3*). The present investigation deals with the ultraviolet absorption characteristics of several combinations of protein and substrate.

Dihydroxyacetone phosphate, when it is dissolved in 0.002*M* phosphate buffer, *p*H 7.0, shows no absorption in the range 280 to 215 mμ. In the presence of muscle aldolase (Fig. 1, experiments 1 and 2), however, there is strong light absorption in the region between 250 and 233 mμ. The apparent decreases in optical density at lower wavelengths, as indicated by the broken lines, are artifacts caused by the fact that protein fluorescence contributes most of the light transmitted by the cuvettes (*4*). The absorption between 250 and 233 mμ increases with increasing concentration of both DHAP (experiment 1) and aldolase (experiment 2). With the highest concentration of DHAP and aldolase a tendency toward saturation is discernible. The shifting of the apparent peak in experiment 2 is an artifact caused by increased fluorescence consequent to increased protein concentration (*4*). The specificity of the enzyme-substrate combination was tested with substitutes for either the protein or DHAP. No absorption was observed in the system DHAP-albumin, or in the systems glucose-6-phosphate-aldolase and dihydroxyacetone-aldolase.

These results suggest a specific requirement for both DHAP and aldolase. D,L-Glyceraldehyde shows no absorption in the range 280 to 225 mμ in the presence of aldolase. This is consistent with the conclusion (*2*) that the aldehyde component of the condensation system is not activated by the enzyme in the absence of DHAP. Additional evidence that the absorption measured is produced by combination of the enzyme with its substrate is found in the obliteration of the absorption by the addition of D,L-glyceraldehyde (experiment 3, curve *J*). The presence of the aldehyde permits the catalysis of hexose-1-phosphate synthesis, and the equilibrium of this reaction leaves very little free DHAP to combine with the enzyme. The addition of excess DHAP (curve *K*) restores the absorption. These results indicate that the absorption observed in the low ultraviolet region is indeed a measure of an aldolase-DHAP complex, and they provide confirmation of earlier findings relating to the ability of muscle aldolase to activate DHAP in the absence of aldehyde and to the inability of the enzyme to activate the aldehyde acceptor.

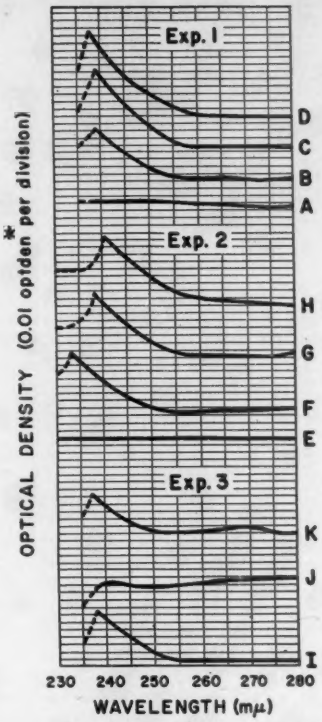


Fig. 1. Experiment 1: effect of DHAP concentration on the absorption spectrum of DHAP-aldolase. Curve *A* shows the absorption determined with 2 mg of crystalline aldolase in both test and reference cuvettes in 1.0 ml of 0.002*M* potassium phosphate buffer, *p*H 7.0. The test cell contained (curves *B, C,* and *D*), in addition, 0.02, 0.07 and 0.1 ml, respectively, of 0.01*M* DHAP, and the reference cell contained an equal volume of water. Experiment 2: effect of adolase concentration on the absorption by DHAP-aldolase. Curve *E* was obtained with 1.0 μmole of DHAP in 1.0 ml of 0.005*M* potassium phosphate buffer, *p*H 7.0. Curves *F, G* and *H* were obtained after the addition of 0.05, 0.15 and 0.25 ml of a 20-mg/ml aldolase solution to both the reference and test cells. Experiment 3: effect of D,L-glyceraldehyde on the absorption spectrum of DHAP-aldolase. Curve *I* was obtained when both cells contained about 2 mg of aldolase in 1.03 ml of water. The test cell contained, in addition, 0.5 μmole of DHAP. Curve *J* was obtained after the addition of 1.0 μmole of D,L-glyceraldehyde in 0.01 ml to both cells. Curve *K* was obtained after the addition of 2.0 μmole of DHAP in 0.12 ml to the test cell and the addition of an equal volume of water to the reference cell. In each experiment the successive curves have been displaced upward in order to simplify presentation. A Cary recording spectrophotometer, Model 14, was used for all measurements. Since use of the term *optical density unit* is technically incorrect, the term *optden*, defined as a unit of absorption measured in a 1-cm cuvette, is used. The optden has the dimension of log $(I_0/I) \times cm^{-1}$.

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6 September 1957

Separation and Detection of Trifluoroacetyl Amino Acids

The need for separating and identifying trifluoroacetyl amino acids has arisen because of increased use of trifluoroacetic anhydride as an acetylating agent for the amino group during synthesis and study of peptides and proteins. Trifluoroacetyl amino acids do not form color complexes with ninhydrin, nor are the usual tests for fluorine adaptable for small quantities of these derivatives. However, the acetylated amino acids will undergo hydrolysis at a *p*H greater than 10 (*1*) with the liberation of the free amino acid. The free acids may then be detected with ninhydrin. Separation of mixtures of the trifluoro derivatives and the free amino acids is readily accomplished by means of paper electrophoresis.

Samples containing a mixture of either trifluoroacetyl glycine and glycine or trifluoroacetyl alanine and alanine were separated on a Reco electrophoresis apparatus (model E-800-2); potassium acid phthalate—sodium hydroxide buffer of *p*H 6.0 and of ionic strength 0.045 was used. The electrophoretic determinations were conducted at 600 v for 1 hour. At the end of this time the paper strips were dried, dipped in 1 percent alcoholic sodium hydroxide (1 ml of saturated sodium hydroxide solution in 99 ml of 95 percent ethanol), and dried. The color

was then developed with acidic-ninhydrin reagent (*2*).

Under the conditions described, a separation of 5.5 cm has been obtained between glycine and trifluoroacetyl glycine, the acetylated derivative migrating to the anode and the glycine remaining almost stationary. The use of the same technique afforded a separation of 4.5 cm between alanine and trifluoroacetyl alanine.

It is conceivable that the technique described may be of use in evaluating (i) the hydrolysis of trifluoroacetyl amino acids by enzymes (*3*), (ii) the solubilizing effect of trifluoroacetic acid on proteins (*4*), and (iii) the cleavage of peptides after trifluoroacetylation of the peptide bond (*5*). In addition, the purity of trifluoroacetyl amino acids may be determined by separating large quantities of these compounds electrophoretically and then checking for ninhydrin-positive compounds (the free amino acids are ninhydrin-positive without basic hydrolysis) (*6*).

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26 September 1957

Occurrence of Plasmalogens in Lipides of Green Peas

The plasmalogens (*1*), a group of glycerophosphatides which contain a higher fatty aldehyde, have been reported to be constituents of various animal phosphatides (*2*). Recently Lovern (*3*) has shown that plasmalogens also occur in vegetable lipides. Commercial samples of the total phosphatide fractions of soybeans and peanuts possessed an aldehyde content equivalent to about 7 percent of palmitaldehyde. Plasmalogens are readily cleaved by acid and mercuric chloride, and the liberated aldehyde may be determined with fuchsin-sulfite solution (Feulgen reagent) (*4*).

The lipides of green peas (*Pisum sativum* L.) have been under investigation because of their probable role in the development of off-flavors during frozen storage of raw peas (*5*). Crude lipide material was extracted from lyophilized raw peas, Perfected Freezer variety, with chloroform-methanol, 2:1. The lipide components of the mixture were then separated by means of a solvent fractionation procedure (*6*). The various fractions were then analyzed for their plasmalogen content with Feulgen reagent. A reaction time of 4 hours at room temperature was employed. The color which developed was extracted from the aqueous reaction mixture with 4 ml of isoamyl alcohol and read at 572 mμ in a Beckman spectrophotometer, model DU, against reagent blanks. The amounts of plasmalogen were determined from a standard curve obtained with known amounts of palmitaldoxime treated as described above.

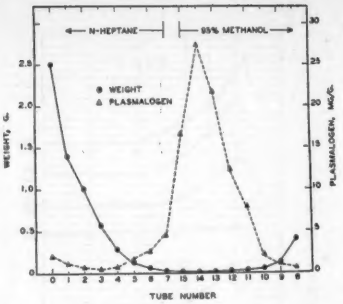

Fig. 1. Countercurrent distribution of acetone-soluble pea lipides between *n*-heptane and 95 percent methanol, showing distribution of weight (circles) and plasmalogens (triangles).

Crude pea lipides were separated into acetone-soluble and acetone-insoluble fractions, the latter primarily a mixture of phosphatides. Phosphatides may be classified on the basis of their solubility in glacial acetic acid and in 95 percent ethanol (*7*). Lecithin (phosphatidyl choline) and cephalin (phosphatidyl serine and phosphatidyl ethanolamine) are soluble in glacial acetic acid, whereas phosphatidyl inositol is not (*8*). Furthermore, lecithin is soluble in alcohol, and cephalin is not. The pea phosphatides (acetone insoluble lipides) were fractionated with glacial acetic acid and with 95 percent ethanol. The plasmalogen content of the phosphatide fractions (expressed as milligrams per gram of lipide) was as follows: alcohol soluble (lecithin), 3.9, alcohol insoluble (cephalin) 7.3, acetic acid insoluble (phosphatidyl inositol) 29.4. Thus the greatest concentration of plasmalogens would appear to be associated with the more complex inositol phosphatides which normally are insoluble in glacial acetic acid.

The acetone-soluble pea lipides were subjected to countercurrent distribution between *n*-heptane and 95 percent methanol in a seven-transfer system with single withdrawal (*6*) at a concentration of 13 percent with respect to each solvent (Fig. 1). It was anticipated that the bulk of the material would consist of triglycerides and that it would, therefore, be concentrated in the nonpolar solvent. In fact, over 75 percent of the total weight of lipides was found in the first three heptane fractions (tubes 0, 1, 2).

The plasmalogens were found to be distributed in the methanol fractions in the region of minimum weight distribution. The maximum amount was 27.5 mg/g in tube 14, which contained but 0.26 percent of the total weight. The tubes on either side contained lesser amounts of the plasmalogens, and only small amounts were present in the heptane fractions which comprised nearly all of the weight. Although phosphatides are normally considered to be insoluble in acetone, their presence in the acetone-soluble portion of a lipide mixture may be attributed to the well-known solubilizing powers of triglycerides.

Inasmuch as the separation of individual lipides from a naturally occurring mixture is always a difficult task, the apparent enrichment of plasmalogens by countercurrent distribution may provide a basis for the isolation and characterization of these unusual phosphatides in vegetable lipides. The lipides of green peas would appear to provide a convenient source of plant plasmalogens for such studies (*9*).

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9. Journal paper No. 1093, New York State Agricultural Experiment Station.

23 September 1957

Sex Chromatin and Sex Differentiation in Human Embryos

In the past, embryologists studying sex differentiation in man paid little attention to the fact that *chromosomally* there exists no indifferent stage because every fertilized egg is either XY-male or XX-female. Chromosome analysis was

Fig. 1. Embryo, 2.4 mm (3 weeks). Heart mesenchyme, male chromatin pattern (× 1250) (hematoxylin and eosin).

too difficult for practical application. Now the situation has changed, since the Barr chromatin test (*1*) renders actual sex recognition possible even at earliest developmental stages (*2*). Recently, examining some embryologically indifferent stages in the Carnegie collection of human embryos, I found that nuclei of the heart mesenchyme are well suited for cytologic sexing (*3*). It is fortunate that a large proportion of the sectioned specimens of this collection are lightly stained in hematoxylin and eosin or in cochineal—techniques nearly as satisfactory as the more specific Feulgen method. Figures 1 and 2 show characteristic male and female chromatin patterns from embryos that had not yet developed any gonads.

In principle, the sex chromatin must be present in every female cell. However, not all tissues are favorable for its recognition. In the adrenal of a 140 mm female fetus it is not possible to point out the special nucleolus in the small, highly chromatic nuclei of the superficial cortex, while the deeper layers are favorable for its recognition (Fig. 3). Primordial germ cells, with their large vesicular nuclei, are also suitable material. Thus, the sex of migrating gonia may be recognized long before the organization of gonad primordia. In the cat, von Winiwarter and Sainmont, as early as 1909 (*4*), described a basophile nucleolus in prophase nuclei of ovogonia and ovocytes. They appraised it as a pair of sex chromosomes but were not aware that it might serve as a means of sex recognition.

Apparently the chromatin nucleolus is the product of allocyclic heterochromasy and conjugation of short segments (chromocentric blocks) of sex chromosomes. Electron-microscope studies indicate that, in the cat, the nucleolus contains four parallel threads. Most authors have assumed that the X chromosomes (carriers of female determining genes) are involved, but it seems equally probable that the chromocenters are parts of the Z chromosomes, which carry the male-determining genes. These questions are discussed more extensively elsewhere (*5*) and can be answered only by further investigations.

It is evident that embryologic sex differentiation can now be studied and evaluated with much more assurance. For some time it was realized that the divergence which histologically characterizes testicular and ovarian development starts somewhere in the seventh week—that is, in embryos of from 10 to 20 mm. In this range embryologists used to be reluctant to evaluate their observations and hurried on to the description of more advanced stages, of 24 mm and over. Now, with the chromatin test available, it is possible to make definite statements about the processes that initiate morphologic differentiation in man (*6*).

At 10 to 11 mm (stage 28), embryos have well-developed indifferent sex glands, with distinct cortical and medullary components. But even after the chromatin pattern has been ascertained, it is impossible to find a sexual difference in the histologic structure of the gonads. At stage 32 (17 mm), the gonads of both sexes have become distinguishable on the basis of structural changes near the surface. The primitive medulla is about equally well developed in both sexes, but the primitive cortex of male embryos begins to separate from the covering peritoneal epithelium, while in the female its adherence remains unchanged. Altogether, the ovary at this stage retains the appearance of the indifferent gonad, while in the male the entire subsurface layer of the primitive cortex becomes welded to the medulla. At the same time, seminal tubule formation becomes noticeable in this thick mantle layer, which contains the majority of all germ cells. The notion of there being first and second proliferations from a germinal epithelium is thereby rendered obsolete. It originated from misinterpretation of conditions observable in ovaries far beyond the stage of actual sex differentiation.

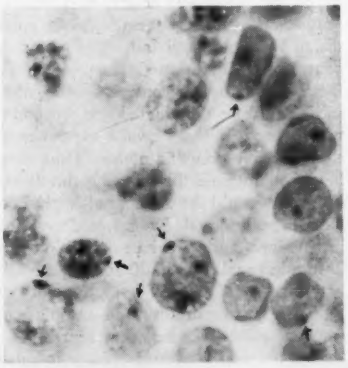

Fig. 2. Embryo, 3.7 mm (4 weeks). Heart mesenchyme, female chromatin pattern. Arrows point to chromatin nucleolus (× 1250) (hematoxylin and eosin).

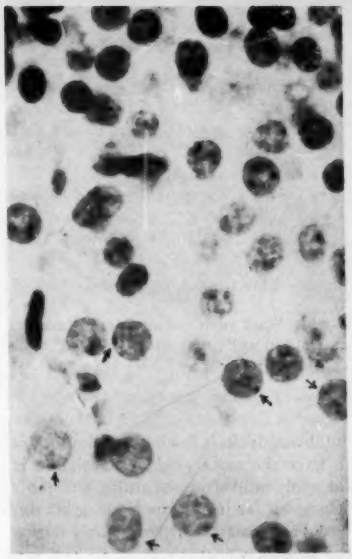

Fig. 3. Female fetus, 140 mm. Adrenal cortical tissue (× 1000) (Feulgen).

It will now also be possible to study, with some accuracy, the not at all rare intersexual traits of development at their earliest stages. In the course of his classical studies, Spaulding (*7*) came to the conclusion that the external genitalia of fetuses are distinctly male or female after the 25-mm stage. However, K. M. Wilson (*8*) showed that some of Spaulding's early "female" fetuses actually had testes. He declared that the appearance of the externals is an unreliable sex criterion before the stage of 50 mm. Reexamination of the pertinent slides in the Carnegie collection confirms the observations of Wilson.

But a more extended study raises two new questions. Up to what stage can a chromosomal male follow the female course and yet finally acquire normal male external genitalia? And which are the causes that delay, in some fetuses, the male differentiation of secondary sex characters? Both questions bear on the problem of male pseudohermaphroditism. Aberrations of this class show a full scale of manifestations, from so-called women with undescended testes to some minor degrees of hypospadias. Before 1950, even at the adult level, the chromosomal sex could only be guessed at. A case which once we assumed to be of female constitution (*9*) is now disclosed, by the chromatin test, to be a male (Fig. 4).

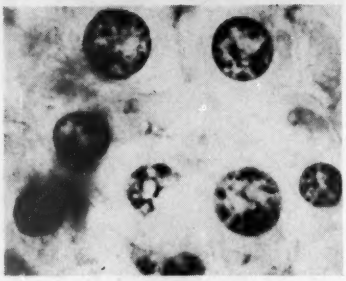

Fig. 4. Adult male pseudohermaphrodite. Interstitial cells of gonad, showing male chromatin pattern (× 1000) (Feulgen).

Obviously it is even more important to have the same guidance available in the study of aberrations at the embryonic stages. So far it appears that testis differentiation starts fairly regularly during the seventh week (about stage 30), but frequently it shows partial delays, with consequent persistence of cortical remnants and retardation of differentiation of the secondary sex organs. Transplacental interactions between male embryo and mother have been suggested as a possible cause (*10*), mainly on the basis of animal experiments (amphibian parabiosis). Recent developments, however, have opened direct approaches to this problem of human sex differentiation (*11*).

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23 September 1957

Operant Behavior during Sleep: a Measure of Depth of Sleep

Most animals spend approximately 30 percent of their lives asleep, yet remarkably few experimental investigations of sleep have been conducted, possibly because of the difficulty of measuring sleep. Processes that are difficult to measure may be studied in behavioral as well as in physical sciences by analyzing the frequency, duration, and degree of their interference with a more easily measured process (*1, 2*). In this report I present a method for measuring the duration and depth of sleep by recording how much it suppresses the rate of a reinforced operant response and compare the results with those obtained by measurement of body movements (*3*).

A sleep-deprived subject wearing an aviator's helmet was placed in a comfortable bed; the helmet contained an earphone through which a pure tone of 2000 cy/sec was delivered to the subject's ear. Each response (subject's thumb closing a microswitch taped into his preferred hand) was recorded on a counter and a Harvard cumulative recorder. A rate analyzer (*4*) controlled a potentiometer which reduced the intensity of the tone after each response. Rapid operation of the switch reduced the tone to zero intensity, and the subject could avoid the tone by continued responding. Slow operation of the switch kept the tone at a moderate intensity. If the switch was not operated, the tone rose to and was maintained at its full intensity (30 db). Thus the subject's rate of response controlled the intensity of the tone.

To record body movements, the base of a brass rod (9 in. long and ¼ in. in diameter) was suspended through the center of a brass washer (⅝ in. inside diameter) by a light spring from the center of the bed spring. A body movement was recorded when slight movements of the subject made the rod contact the washer.

Sleep records were taken under conditions of (i) 15 hours' sleep deprivation; (ii) 15 hours' deprivation plus 1½ grains of seconal ingested 5 minutes before retiring; (iii) 38 hours' deprivation; and (iv) 15 hours' deprivation without the tone. Since the latter condition was presented last, it provided a control for conditioned responding effects. Prior to the control session, the subjects were instructed to respond whenever they were awake at the rate they had on previous nights. Thus, behavior maintained by escaping the aversive tone could be compared with behavior maintained by recalled verbal instructions and previous conditioning. Two adult males, aged 20 and 34, served as subjects.

Figure 1 contains sample cumulative response records (selected as representative of 40 similar records) for one subject during eight continuous hours in bed on each of six different nights. Records for the first 4 hours (Fig. 1, top) show operant behavior during the deep initial

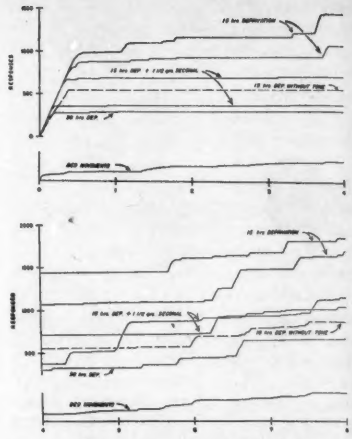

Fig. 1. Cumulative responses reinforced by a reduction in tone intensity are plotted against time in bed. (Top) First 4 hours in bed; (bottom) second 4 hours in bed. The lower the slope of the curves, the more intense was the tone and the deeper was the sleep. A cumulative record of body movements is presented at the bottom of each part.

sleep, and records for the last 4 hours (Fig. 1, bottom) show the subsequent light waking state characterized by bursts of responding. Records of short daytime naps contain response bursts very similar to those of the light waking state. The major effects of sleep deprivation and sedation on operant responding during sleep occur during the first 4 hours of sleep.

The two records for 15 hours' deprivation show the pattern of normal sleep. The subject spent 24 minutes in bed before the response rate dropped (sleep latency), and an additional 16 minutes passed before the rate dropped to zero (sleep onset). The period of deep sleep (from the time responses dropped to zero rate until 100 responses were emitted and during which the tone sounded at its full intensity) was 2 hours. Notable is the fact that approximately the same amount of responding occurred over the whole night on both 15-hour deprivation records, despite the separation of the two curves by 400 responses after 4 hours of sleep. The same effect appeared for the condition of 15 hours' deprivation plus seconal.

The addition of seconal to 15 hours' deprivation produced deep sleep sooner (sleep latency, 13 minutes) and more abruptly (sleep onset, 3 minutes) than did 15 hours' deprivation alone. Also, seconal doubled the deep sleep period (4 hours) and produced deeper sleep since fewer response bursts were emitted.

The 38-hour deprivation record was similar to the seconal record, with a short sleep latency (7 minutes) and an abrupt

sleep onset (5 minutes). The deep sleep period (5½ hours) was longer and was characterized by fewer response bursts than it was for both normal and drugged sleep conditions.

The control record showed a 23-minute sleep latency (similar to unconditioned responding) but an immediate sleep onset (0 minutes). Thus, conditioned responding did not show the gradual sleep onset characteristic of unconditioned responding. Note also that the initial conditioned response rate during the latency period (base line) was lower than the unconditioned rate, showing inaccurate recall. The deep sleep period was longer (5¾ hours), and the rate of response during deep sleep was lower for conditioned responding than for unconditioned responding.

The records of body movements did not show the sleep-latency or sleep-onset differences for the conditions of deprivation and sedation that were shown by operant responding. Fewer movements were made during deep sleep than during the later waking state for all conditions, however, and therefore the method could show that deprivation and drugs increase the duration of deep sleep. This effect has been reported previously (*5*).

The subjects' reports of the number of times they recalled awakening were not related to the number of response bursts in the sleep records. Neither subject reported ill effects of the experiment, and both felt rested after the sessions.

These observations show that unconditioned operant responding to turn off an aversive stimulus during sleep is more sensitive to intermediate sleep levels and to deprivation and drug effects than is responding supported by verbal instructions with previous conditioning or the recording of body movements. This sensitive and widely applicable method should enable scientists to study sleep behavior more effectively. It can be used to investigate the effects of drugs, neurosurgery, deprivation, and awakening stimuli on the sleep of lower animals as well as on that of human beings. Records of operant responding during sleep and hypnosis should be compared with electroencephalographic records in normal and abnormal subjects.

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11 October 1957

Surface Ionization of Silver; Silver in Meteorites

Isotopic dilution followed by mass spectrometric analysis has been applied to many of the naturally occurring elements (*1*). Concentrations may be accurately determined at the level of one part per million (ppm) and even lower. Surface ionization of a solid sample is the usual source of ions for the heavier elements. A recent study (*2*) of microgram amounts of lead, uranium, and thorium from typical rock minerals emphasizes the importance of these sensitive techniques to geochemistry. The experiments described in this report (*3*) demonstrate that silver may be similarly analyzed.

These techniques may lead to a better understanding of the distribution of silver in the earth and in meteorites. The analysis of small amounts in meteorites is especially important for the following reasons.

1) A recent estimate (*4*) places the cosmic abundance of silver at 0.26 atom per million atoms of silicon. This value is based on a reasonable interpolation from elements whose abundances are better established. A typical earlier estimate (*5*) is an order of magnitude higher. In this case, the ratio of 2.7 atoms of Ag per million of Si is based on analyses of meteoritic phases by the Noddacks. There are several indications that their concentration may be too large (*6*).

2) The isotopic composition of silver may reveal part of the early history of the solar system. If processes leading to the formation of the planets occurred shortly after nucleogenesis, variations in the relative amounts of Ag^{107} and Ag^{109} may exist as a result of the decay of Pd^{107}. The half-life of this extinct nuclide is reported (*7*) as 7.5×10^{-6} years. Even with very favorable fractionation of Ag relative to Pd, the detection of such an effect would imply that the period between nucleogenesis and the formation of the earth was considerably shorter than the minimum time estimated on the basis of the 17.2×10^{-6}-year half-life of I^{129} (*8*).

Although positive results from a search for isotopic differences in silver appear to be unlikely, a sample of troilite has been investigated. This material was selected initially because of its relatively high concentration of Ag. It was hoped that the troilite either might have scavenged Ag^{107} from the surrounding palladium-rich (*9*) metallic phase or might have remained isolated from an early stage and thus retained primeval silver.

Troilite from the Xiquipilco (Toluca) iron meteorite, a medium octahedrite, was received in the form of slabs several millimeters thick and several centimeters in breadth (*10*). The surface was ground off with an Al_2O_3 refractory wheel (dental size). The pieces were rinsed several times with $2N$ H_2SO_4 (*11*) and quadruply distilled water.

The dried sample, weighing 18.40 g, was dissolved, except for a black residue, in two stages requiring nearly 20 ml of concentrated H_2SO_4 in about 250 ml of water. The residue was centrifuged away from most of the iron and nickel, washed, and digested in quartz-distilled concentrated HNO_3. This solution of about 30 ml was mixed with 30 ml of a 20 percent solution of purified ammonium citrate. The *p*H was adjusted to slightly greater than 1 with NH_4OH (carefully prepared from gaseous NH_3 and distilled water). Successive 2- to 3-ml portions of a dithizone solution (*12*) were briefly shaken with the acid solution until they became violet after shaking instead of yellow (silver dithizonate). The $CHCl_3$ was evaporated, and the residue was taken to dryness several times with concentrated HNO_3. The residue was taken up with a few drops of concentrated HNO_3, diluted to about 25 ml, and the *p*H was adjusted to between 1 and 1.5 with NH_4OH. Extraction with standard dithizone solution in 2-ml portions required 20 ml and was equivalent to 30 μg of silver. This is only an upper limit for the amount of Ag, for Hg is also extracted under these conditions. The dithizonate was again converted to nitrate (*13*).

A chunk of Canyon Diablo iron meteorite, free of visually obvious troilite inclusions, was rinsed four times with $6N$ H_2SO_4 and washed with distilled water after each acid rinse. The dried weight of this piece was 102.6 g. It was almost completely dissolved in 150 ml of concentrated H_2SO_4 and 550 ml of distilled water. The odor of H_2S was present during the reaction. Further treatment of the residue required approximately an additional 40 ml of concentrated H_2SO_4 and roughly 700 ml more water. Gaseous H_2S was also added shortly before separation of most of the iron and nickel in the supernatant from the residue. The final residue consisted of sulfur, black particles, and a small amount of heavier, metallic slivers about 1 mm long.

The solids were digested with about 150 ml of concentrated HNO_3. The resulting 25 ml of solution were mixed with 25 ml of the ammonium citrate solution, adjusted to a *p*H of 1.5, and extracted

Table 1. Surface ionization of microgram amounts of silver.

Run	Source of sample	Filament type	Ag^{107}/Ag^{109} average atomic ratio	Number of spectra	Mean deviation (±)
1	Terrestrial	Triple	1.083	122	0.020
2	Terrestrial	Single	1.079	104	0.015
3	Terrestrial	Single	1.083	296	0.021
4	Terrestrial	Single	1.084	97	0.015
5	Meteoritic	Single	1.067	16	0.028

in brief shakes with 2-ml portions of dithizone solution. The first 12 ml were violet after shaking. Later additions turned only pale violet. The $CHCl_3$ solution was back-extracted with 30 ml of NH_4OH solution at a *p*H of 8 to 9. The residue, after evaporation of the $CHCl_3$ and digestion with concentrated HNO_3, was again extracted at a *p*H somewhat greater than 1 with the standard dithizone solution. The only color which appeared was a violet during the addition of the first 10 ml, following which the color was only slightly changed from that of the original solution. No yellow color characteristic of silver dithizonate was observed. The minimum amount that could be detected was 4 μg. Unoxidized silver (*14*) as scattered atoms may not have attached itself to centrifugable solids and may have been lost in the supernatant. Other experiments showed that most of the Ag_2S formed in 25-μg and even in 50-μg Ag solutions could not be centrifuged down, at least not in the absence of a carrier. However, if even a yield as low as 25 percent is assumed, the concentration of Ag in this iron meteorite is less than 0.2 ppm (*15*).

The silver extracted from the troilite indicates a concentration of no more than 1.6 ppm (assuming 100-percent yield). If the yield is only 50 percent, the concentration is no more than 3 ppm. These figures do not contradict the estimate of about 5 ppm made with the emission spectrograph of Oiva Joensuu of the department of geology, University of Chicago. Joensuu also found that the concentration of silver in the metal phase of the Canyon Diablo meteorite is no more than 1 ppm. Lovering (*16*) has found less than 0.5 ppm of Ag in three troilites, including Toluca. The values indicated by these experiments are lower by roughly an order of magnitude than the averages previously accepted for meteoritic iron and troilite (*5*), but they agree with the estimate of Suess and Urey (*4*) for the cosmic abundance of silver.

The mass spectrometer used to compare the isotopic ratio of the meteoritic silver to that of terrestrial silver was a single-focusing instrument with a 12-in. radius of curvature and a 60° deflection. The output of the electron multiplier was measured with a vibrating-reed electrometer. Filaments were tungsten ribbon, 30 mil by 1 mil. Ion intensities were recorded on a strip chart. The amounts of silver on the filaments ranged from a few *micrograms* to around 15 μg. The smallest amounts previously used for mass spectrometric analysis appear to be 3 *milligrams* (*17*).

The sensitivity of multiple filaments (*18*) was first thought to be an advantage. Of two trials with Ag_2S on the side filament, one produced completely reasonable data (Table 1, run 1). Other masses were present with low intensity, but in this case there was no evidence for impurity peaks at masses 107 and 109. In general, though, multiple-filament experiments (*19*) were characterized by spurious, unstable, and unreliable peaks (mass 107 often too high) and by little control of ion beam intensity by varying the temperature of the side filament.

When $AgNO_3$ and borax were placed on either oxidized or unoxidized single filaments, some emission of Ag was observed, but spurious ions were too numerous to be tolerable (*20*). To reduce the extraneous signals from cations from borax, a small drop of saturated boric acid was added to the silver compound on the filament instead of borax. After careful evaporation to dryness, the current warming the filament was increased to bring it to a dull glow for a few minutes. Filaments prepared in this way with about 10 μg of Ag and mounted in the mass spectrometer displayed hours of steady emission of Ag^+ with high intensity. The particular silver compound placed on the filament before boric acid is added evidently is not important as long as it is reasonably pure, for in run 2 (see Table 1) boric acid was added to Ag_2S on the filament and in runs 3 and 4, to $AgNO_3$.

The meteoritic silver (run 5) was placed on the filament as a strongly basic solution of $Ag(NH_3)_2^+$. Then boric acid was added. This run was of very low intensity and suggested that the amount of silver which had been placed on the filament was no more than 1 microgram and probably less. Possibly the metal extracted from the troilite was mostly mercury rather than silver. Some of the 107 peaks were corrected for 0.5 to 5 percent of K_2BO^+, which was present as an impurity. This correction was not necessary for the high-intensity runs 2 to 4. Here extraneous masses were not usually observed, although occasionally mass 108 was discernible at less than 0.5 percent of the intensity of the main peaks. Only in run 2 were ratios (obtained with lower intensity and not included in the average) observed that agreed closely with the average of run 5. However, within the error of the latter, there is no difference in isotopic abundances in the Ag samples (*21*). In the present experiment the ratio of Ag^{107} to Ag^{109} is 2.5 percent higher than the value of 1.055 ± 0.003 reported by White and Cameron (*22*). The chemical atomic weight calculated from our ratio with recent values of isotopic masses (*7*) is 107.870, while that calculated from White and Cameron's data is 107.883. This is in good agreement with the observed value of 107.880. Presumably our discrepancy is due to discrimination of the mass spectrometer, although no source magnet was used. All ratios have been corrected for mass discrimination of the electron multiplier (*23*).

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10. The material was received from H. E. Suess, now at Scripps Institution of Oceanography, La Jolla, Calif. Suess has subsequently commented that no precautions were taken to avoid contamination in the preparation of the slices This may account for the fact that the isotopic composition of the lead in this material is almost as radiogenic as modern average crustal lead. Suess obtained the meteorite from H. Rose of the Hamburg Mineralogical Institute, Hamburg, Germany.
11. Distilled in Pyrex from concentrated acid which meets ACS specifications.
12. The solution consisted of 2 mg of diphenylthiocarbazone in 500 ml of H_2SO_4-extracted, spectrophotometer grade $CHCl_3$.
13. Comparable volumes of the reagents (nearly 20 ml of concentrated H_2SO_4, 100 ml of concentrated HNO_3, and approximately 150 ml of distilled water) were mixed with 40 ml of the ammonium citrate solution. This aqueous phase (about 500 ml after adjustment to a *p*H of 1.5) was extracted with excess dithizone in 75 ml of $CHCl_3$. The nonaqueous phase was then back-extracted three times with NH_4OH (*p*H 7.5 to 8) to remove ex-

cess dithizone. The $CHCl_3$ was evaporated, and the residue was taken to dryness six times with concentrated HNO_3. The residue was taken up in HNO_3 and extracted at a *p*H of 1 with 1 ml of standard dithizone solution. No color change was noted. Contamination appears to be much less than 1.5 μg.

14. The values of $\Delta Ff°$ [*Natl. Bur. Standards (U.S.) Circ. No. 500* (1952)] for sulfides indicate that Ag should not occur as Ag_2S in meteorites.
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19. Experiments by this technique with Ag_2SO_4 and Ag^+ in borax were not successful. A little success was had in one run with $AgNO_3$ placed on the side filament and also with $AgNO_3$ treated with phosphoric acid on the filament.
20. Attempts to examine the isotopic composition of silver in Ag_2S, $AgNO_3$, or Ag_2SO_4 with single-filament sources were not successful. Silver peaks were observed when phosphoric acid was used with the silver sample, but the 109 peak was often as high as the 107 peak and sometimes higher. With phosphorous acid and a single filament, the results were no better; the ratio of Ag^{107} to Ag^{109} varied from less than 1 to more than 1.
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16 September 1957

Adrenal Lipid Response in Chinese Hamsters Infected with Trichinella spiralis

The unique paucity of histochemically demonstrable lipid in the adrenal of the golden hamster (*1*), together with its atypical response to stress situations (*2*), suggests the possibility that the Chinese hamster may present a similar picture. Leathem and Stauber (*3*), using the intracellular protozoan parasite *Leishmania donovani*, showed that the adrenal cortex of the golden hamster responded to the stress of infection with a progressive accumulation of sudanophilic substance.

The present study (*4*) was carried out with 14 Chinese hamsters, each of which had been fed approximately 100 *Trichinella spiralis* larvae from a donor animal. Adrenals were removed from infected animals (under Nembutal anesthesia) on days 3, 5, 14, and 26 and from normal controls at the beginning of the experiment. They were fixed in 10 percent formalin and embedded in gelatin, and sections were stained with Sudan black B (*5*).

The adrenals of normal Chinese hamsters, unlike those of the golden hamster, were shown to have uniformly distributed lipid material in the cortex (Fig. 1*A*). Infected animals sacrificed on the third day of parasitization exhibited some loss of lipid in the outer zone of the cortex (Fig. 1*B*). On the fifth day, cortical lipid was absent (Fig. 1*C*). On the 14th day of infection, adrenals exhibited a renewal of sudanophilic substance. The latter was most marked in the inner zone of the cortex (Fig. 1*D*). By the 26th day of infection, the normal diffuse pattern of lipid was again evident (Fig. 1*E*).

The results reported here indicate that the adrenal of the normal Chinese hamster resembles that of other mammals more closely than does that of the golden hamster. Similarly, the adrenal of the Chinese hamster responds to the stress of infection in a more conventional way. The stress, in this case, is a result of the intestinal response to the adult worm of *T. spiralis*. Insofar as adrenal lipid is a measure of stress in this host-parasite complex, we see a rapid loss of the indicator material during the early development of worms in the intestine, followed by recovery at a time (the 14th to 26th day) which corresponds to the secondary insult of migrating larvae. Adult female worms with larvae fully developed at six days of infection have been observed, and larvae have been iso-

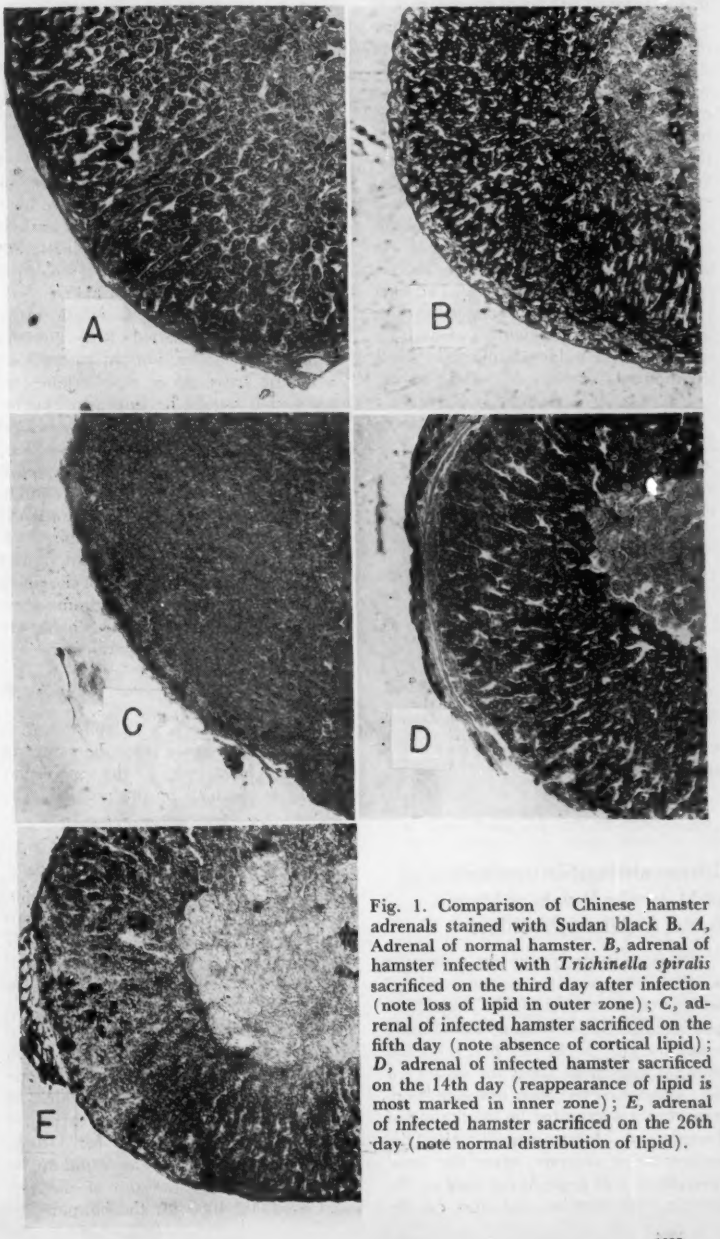

Fig. 1. Comparison of Chinese hamster adrenals stained with Sudan black B. *A*, Adrenal of normal hamster. *B*, adrenal of hamster infected with *Trichinella spiralis* sacrificed on the third day after infection (note loss of lipid in outer zone); *C*, adrenal of infected hamster sacrificed on the fifth day (note absence of cortical lipid); *D*, adrenal of infected hamster sacrificed on the 14th day (reappearance of lipid is most marked in inner zone); *E*, adrenal of infected hamster sacrificed on the 26th day (note normal distribution of lipid).

lated from cardiac blood at this time. Serum from Chinese hamsters infected 20 days previously was capable of forming, *in vitro*, circumoral precipitates on adult female worms isolated from the intestine of the golden hamster.

In a parallel study (*6*), it was found that animals which had been infected for 14 to 26 days exhibited severe generalized myositis. Although the latter condition doubtless constitutes a stress situation for the host, it does not appear to be reflected in changes in adrenal lipid within the time limit of this study. Hematoxylin- and eosin-stained sections of the adrenals exhibited no evidence of pathological changes during the course of the experiment and beyond (to 112 days of infection). Adrenal weights (*6*) bore no obvious relationship to the status of the infection. It is possible that stress brought about by the migratory phase of the infection would be mediated or reflected in other endocrine changes or that measures of adrenal response other than sudanophilic substance would resolve this apparent duality of physiological response. Data on the Chinese hamster response should constitute a useful adjunct for comparative study in connection with the studies of the singular adrenal responses of the golden hamster in stress situations.

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24 June 1957

Ultracentrifugal Determination of Molecular Weight of Myosin by the Archibald Procedure

Attempts to determine the molecular weight of myosin from ultracentrifugal sedimentation and diffusion data have not, so far, been successful. This failure is due not only to the fact that there has been no agreement about the values for the sedimentation and diffusion constants but is aggravated by the finding of Parrish and Mommaerts (*1*) that the sedimentation constant, after the usual corrections, still depends not only on the protein concentration but also on the temperature and rotor speed. These kinetic anomalies, which we have confirmed in the present work, are entirely unexplained and seem to invalidate any efforts to determine the molecular weight in the traditional fashion.

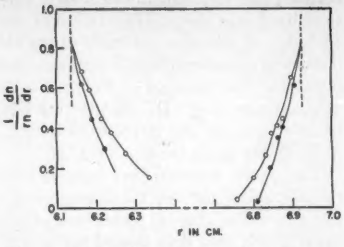

Fig. 1. Archibald plots for the ultracentrifugal sedimentation of myosin. Protein concentration, 0.5 percent; temperature, 5°C; rotor speed, 4196 rev/min; duration, 24 and 42 hours. The parameter $\frac{1}{rn} \times \frac{dn}{dr}$ is plotted against the distance in the cell, r; the curves, extrapolated toward the meniscus and the bottom of the cell (vertical dotted lines), indicate the values for δ.

It seemed advisable, therefore, to attempt a determination with methods which have an equilibrium rather than a kinetic basis. Since equilibrium centrifugation would be impracticable because of the long duration, we have followed the direction indicated by Archibald (*2*), in which the approach toward sedimentation-diffusion equilibrium is investigated. We have made the required measurements in a Spinco ultracentrifuge equipped with an optical system for the observation of Rayleigh interference fringes. These measurements, as explained by Archibald, are intended to estimate a parameter

$$\frac{1}{rn} \times \frac{dn}{dr} = \delta$$

in which n is the protein concentration and r is the distance from the center of rotation, from which the molecular weight is obtained by the relation

$$\delta = M(1 - V\rho)\omega^2/RT$$

In 13 separate experiments (for example, Fig. 1) on four different crystallized myosin preparations with moderate variations of concentration, rotor speed, duration, and temperature, the molecular weight was consistently found to be 382,000 with individual variations within ± 20,000. In all instances, the same molecular weight was obtained from extrapolation toward the top and toward the bottom of the cell. In one more elaborate experiment, in which, at 4196 rev/min and at 5°C, exposures were taken every 12 hours for 3 days, the molecular weight was found to be 385,000 ± 4000 for the top of the cell and 375,000 ± 4000 for the bottom.

These values are in definite disagreement with all results published so far, but they seem to rest on a much better experimental and theoretical foundation (*3*). It may be pointed out that a figure of 380,000 to 400,000 corresponds to the presumable weight of the myosin moiety of the 504,000 g of actomysin which, according to Nanninga and Mommaerts (*4*), reacts stoichiometrically with 1 mole of adenosine triphosphate. Hence, the myosin molecule has one active center for this interaction (*5*).

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3 September 1957

Effect of Kinetin and Gibberellic Acid on Excised Anthers of Allium cepa

The process of meiosis and the subsequent formation of haploid male gametes is one of the most important events in the life history of an angiosperm. Recently some attempts have been made to cultivate anthers on nutrient media and to follow the course of meiosis and pollen development in order to understand their physiology and biochemistry. Anther culture technique not only seeks to throw light on the mechanism of meiosis but can be of great help in solving problems of cytology and of growth and differentiation.

So far, the best development of pollen *in vitro* has been obtained with anthers of *Trillium erectum* with the help of 25 to 50 percent coconut milk (*1, 2*). Linskens (*2*) believes that the beneficial effect of coconut milk is due to its nucleic acid content. Anthers excised earlier than pachytene or even diplotene-diakinesis generally failed to undergo meiosis in culture media. It is believed that certain substances are transported to the anthers from the flower or from some other region of the plant at this stage and that these substances are responsible for the development of the anthers.

Recent studies have shown that two new growth-promoting substances, kinetin (*3*) and gibberellic acid (*4, 5*), have a very marked effect on the growth of

plants and plant tissues. In this report the results of some experiments on the effect of kinetin and gibberellic acid (*6*) on the growth and development of excised anthers of *Allium cepa* are presented (*7*). To the best of my knowledge, no other report is known where excised anthers have been grown from leptotene to one-celled microspores with such a high degree of survival as is presented here.

White's modified basic medium (1 percent sucrose and 2 mg of indoleacetic acid per liter) was used throughout. Kinetin (aqueous solution; dissolved with the help of 1*N* hydrochloric acid; concentrations used were 0.01, 0.05, 0.1 and 0.15 mg/lit) and gibberellic acid (dissolved in absolute ethyl alcohol; concentrations used were 1, 5, 10 and 25 mg/lit) were incorporated in the basic medium.

The plants were raised under normal field conditions during March and April. Prior to inoculation, one out of the six anthers (all the six anthers were at approximately the same stage of development) was removed and an iron-aceto-carmine squash was prepared to check the stage of development. The other five anthers were then sterilized in an 8 percent calcium hypochlorite solution for 3 minutes, washed with sterile, double-distilled water, dissected, and inoculated under aseptic conditions. In all, 1050 anthers (210 cultures of five anthers each) were cultured. All the cultures were exposed to diffuse laboratory light and stored at 20° to 25°C.

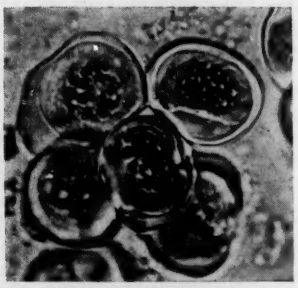

Fig. 1. Anther cells excised at leptotene-zygotene (×540).

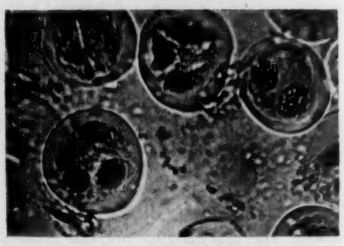

Fig. 2. Anther cells excised at leptotene-zygotene and cultured for 2 days in White's medium with 0.05 mg of kinetin per liter. Dyads and tetrads (about ×500).

In White's medium, anthers excised at zygotene, leptotene-zygotene (Fig. 1), and metaphase I degenerated within 2 days. Their cell walls thickened, and their contents were gradually used up. In double-distilled water and in 0.8 percent agar, anthers excised at leptotene-zygotene degenerated and their contents were used up within 6 days of culture.

In White's medium supplemented with kinetin, the optimum concentration of kinetin (Fig. 2) proved to be 0.05 mg/lit, and in this medium anthers excised at leptotene-zygotene showed, after 9 days, 10 percent mother cells in metaphase I, 40 percent in metaphase II, and 45 percent tetrads, while 5 percent remained undeveloped.

In White's medium with gibberellic acid, optimum development was seen at 5 mg/lit (Fig. 3), and after 2 days there were 12 percent undeveloped mother cells, 32 percent dyads, 14 percent cells in metaphase II, and 42 percent in telophase II; after 6 days 87 percent of these had formed tetrads, while 13 percent had degenerated.

In anthers excised at leptotene-zygotene, and cultured in White's medium supplemented with kinetin (0.05 mg/lit) and gibberellic acid (5 mg/lit), only 5 percent of the microspore mother cells remained undivided, 20 percent formed dyads, 17 percent showed anaphase II, and 58 percent formed tetrads within 2 days (Fig. 4). This was as good as, or slightly better than, the development observed *in situ*. Within 4 days all the cells had formed tetrads. The anther filament was removed during inoculation, but the short portion attached to the base of the anther grew to about 1 mm in several cases and showed two to three small fingerlike processes at the lower end.

Thus *Allium cepa* anthers excised at leptotene-zygotene or even at leptotene grew satisfactorily in media containing kinetin and gibberellic acid, or both, and produced tetrads and one-celled microspores. In all other plants investigated so far (*1*), anthers excised at this stage failed to develop. It is known that kinetin induces cell division, but there is no report that gibberellic acid induces cell division except a recent short report by Sachs and Lang (*5*), who report that "gibberellin causes a great increase in the number of cell divisions in the subapical region of nonvernalized biennial *Hyoscyamus niger* rosettes, thus proving that gibberellin may function as a regulator not only of cell elongation, but also of cell division." The fact that gibberellic acid also causes cell division (as shown here) in addition to cell elongation, is a further evidence in favor of its being an auxin. The occurrence of gibberellinlike substances has been recently demonstrated in *Echinocystis* seeds (*8*).

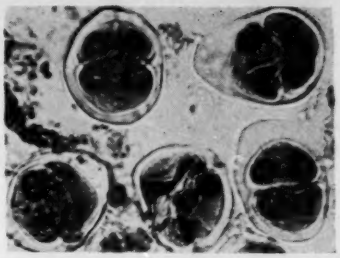

Fig. 3. Anther cells excised at leptotene-zygotene and cultured for 2 days in White's medium with 5 mg of gibberellic acid per liter. Late telophase II (about ×500).

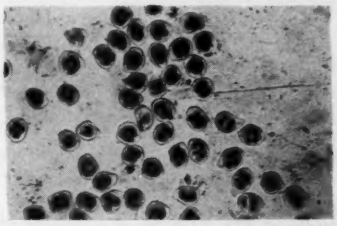

Fig. 4. Anther cells excised at leptotene-zygotene and cultured for 2 days in White's medium with 0.05 mg of kinetin and 5 mg of gibberellic acid per liter. Mostly tetrads, a few dyads (about ×130).

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29 August 1957

Book Reviews

Fads and Fallacies in the Name of Science. (Revised edition of *In the Name of Science.*) Martin Gardner. Dover, New York, rev. ed., 1957. 363 pp. Paper, $1.50.

It sometimes surprises me, as it may have surprised other readers of this journal, that no one has yet founded an American Association for the Advancement of Pseudoscience. Its potential membership would be enormous—the adult population of the United States plus or minus a few million. Furthermore, we can all think of a number of persons in high places who could be persuaded to serve on its board of trustees.

In the beginning, at least, the association might have rough going. The genuine pseudoscientist is reluctant to leave his celluloid tower and instinctively resists being organized. But he would have much to gain. Among other things, the association could work for more adequate financial support and legal representation, fuller coverage of its activities in the nation's press (the ranks of pseudoscience writers are dwindling), and the education of the few publishing houses which still reject pesudoscientific works, even those works endorsed by literary critics and magazine editors.

We may be thankful that no such body exists. Pseudoscience is doing well enough as it is, without the benefit of organization. Many of its most widely hailed efforts are described and dissected in *Fads and Fallacies,* a revised and expanded edition of a volume published five years ago. Martin Gardner, the *Scientific American*'s mathematical-puzzles editor, has written an illuminating and often depressing account of scientific nonsense prepared in the name of science. Bridey Murphy is here as the latest example of the way in which the cheapest sort of publicity can cash in on the notion of an afterlife.

The long parade includes Reich's blue-glowing "orgone energy," Immanuel Velikovsky's colliding worlds, L. Ron Hubbard's "dianetics," which out-Freuds the Freudians by tracing our troubles back beyond early childhood to the instant of conception. There are also flat-worlders, flying-saucer enthusiasts, anti-evolutionists, dowsers, and a rich variety of obscure and not-so-obscure medical crackpots. Their writings are often amusing, but Gardner is not amused. He points out that such works are becoming increasingly popular—a situation which would not exist if nonscientists were as well acquainted with the basic approach and attitudes of science as they are with the specific achievements of applied research.

"In the last analysis, the best means of combating the spread of pseudoscience is an enlightened public, able to distinguish the work of a reputable investigator from the work of the incompetent and self-deluded." *Fads and Fallacies* offers the layman some general ways of telling the difference. For instance, the pseudoscientist commonly considers himself a misunderstood genius, unabashedly regards workers in the same field as crooked or stupid, and has a compulsion to attack the greatest scientific investigators and their theories. Also, he often writes in a complex jargon—a fault he shares with some of his more legitimate colleagues!

Gardner tends to overprove his points, to devote too much space to the details of past cases. Certain current areas of pseudoscience are omitted entirely. To cite only one example, there is no systematic survey of the sort of unscrupulous, dishonest advertising which exploits and degrades everything that science stands for. But this book is a valuable indication of troubles ahead—and of the fact that an active fight against all forms of pseudoscience is one of the most important social responsibilities of the scientist.

JOHN PFEIFFER
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Statistische Thermodynamik. Arnold Münster. Springer, Berlin, 1956. 852 pp. DM. 138.

This book is impressive in its bulk, thoroughness, quality, organization, clarity, and typography. It may well become a standard, if not a classic, reference book in the field of statistical thermodynamics. The author has succeeded in presenting a panoramic view of the field as a unified whole, and in discussing the major concepts and techniques against a background of numerous applications important to physicists and physical chemists. Literature references are copious and remarkably current. An attractive feature, too often lacking in theoretical works, is the large number of tables and graphs of experimental data.

Its four major divisions are general foundations, theory of gases, theory of crystals, and theory of liquids. The discussion of foundations invites comparison with Tolman's famous tome, devoted entirely to this subject. Tolman is discursive, devoting almost 200 hundred pages to an introductory presentation of quantum mechanics, for example, in order to exhibit the foundations of quantum statistics with admirable clarity. Münster is much more concentrated, including in his 300-page discussion not only most of the territory covered in Tolman but also the Darwin-Fowler method and a 60-page chapter on molecular distribution functions, covering the work of Born and Green, of Kirkwood, and of Mayer. Münster is very clear, but as might be expected, since he is more comprehensive, more effort is required to read him than to read Tolman.

The five chapters on gas theory (173 pages) deal with the standard problems involving ideal gases (for example, monatomic and polyatomic gases, ortho and para hydrogen, molecular rotations and vibrations); chemical equilibrium in gases; theory of the second virial coefficient; theory of condensation (including the Einstein condensation); and molecular distribution functions for real gases. A fair-sized fraction of the material was worked out in the last decade and thus has been available only in scattered journal articles heretofore. This last remark applies to a surprisingly large amount of material throughout the book. It is a pity the author did not include a discussion of the increasingly important plasma state of gases in this section. Saha's equation would have naturally found a place here, also. It is hoped that Münster will add such a chapter in a future edition.

Five chapters (171 pages) cover crystal theory: ideal crystals; crystal-vapor equilibrium and the Nernst heat theorem (two chapters); and cooperative phenomena (three chapters). The first of these three chapters gives the classical treatments of order-disorder of Gorsky, Bragg and Williams, Bethe, and Kirkwood. The second goes into the matrix theory of the Ising model in considerable detail, giving the fundamental contributions of Onsager and others. The third discusses solid solutions and rotational transitions. I was somewhat surprised at the omission of a discussion of semiconductors, which would have afforded an opportunity to treat the electron gas

from the classical, dilute case to that of complete degeneracy, with many comparisons between theory and experiment. It is hoped that such a chapter will appear in a later edition. Current solid state theory has been so profoundly affected by semiconductor progress in the last decade that the lack of a chapter on semiconductors is, in my opinion, a regrettable omission.

It is a little strange to find the statistical thermodynamics of radiation, including Planck's law, compressed into a few pages and treated as a digression sandwiched between the Einstein and Debye theories of crystal properties. Perhaps I am sentimental, but I cannot help feeling that Planck's law should be set to better advantage in any complete treatment of statistical thermodynamics.

The four chapters of the last part (on theory of liquids, 173 pages) are devoted to pure liquids, solutions of nonelectrolytes, strong electrolytes, and solutions of macromolecules. Cooperative theories of melting, theory of free volume, critical points, orientation effects, and Debye-Huckel theory are among the topics discussed. A mathematical appendix concludes the book.

JEROME ROTHSTEIN
Edgerton, Germeshausen & Grier, Inc., Boston, Massachusetts

Oeuvres de Lavoisier. Correspondance. Fascicule II. René Fric, Ed. Michel, Paris, 1957. 285 pp. Illus.

Fascicle I of this work was reviewed in *The Scientific Monthly* [**83**, 211 (1956)]. It was there pointed out that the correspondence of the great French chemist Antoine-Laurent Lavoisier (1743–1794) is now being published as a supplement to the standard six-volume 19th-century edition of his collected writings. Hence, fascicle II may be considered to constitute pages 251 to 536 of volume VII of the *Oeuvres de Lavoisier* (the pagination is continuous with that of fascicle I). These pages contain 162 documents, emanating from the six years 1770 to 1775, inclusive. The costs of issuing fascicle II were contributed in part by certain outstanding French business firms and by the University of Delaware.

Here, as in fascicle I, we see Lavoisier tirelessly striving to wrest from nature a few of its tenaciously guarded secrets. In this connection we are given a photocopy of the famous memorandum which he wrote with his own hand and deposited under seal with the secretary of the French Academy of Sciences, on 1 November 1772, for the purpose of fixing the date of a discovery about combustion that he was not yet ready to announce publicly (pages 388–389). The foresight shown on this occasion is so characteristic that it is surprising to see him ask one of his correspondents to return his letters for several days because he wanted copies made of them (page 268); evidently even the methodical Lavoisier sometimes neglected to preserve the preliminary drafts of his messages, so that after the latter had been sent off, he had no permanent record of what he had written.

In these days of intensive specialization it is particularly interesting to catch fleeting glimpses of Lavoisier's manifold scientific activities outside the field of chemistry proper. His correspondence shows him observing astronomical phenomena, accumulating meteorological data, conducting a geological survey, and investigating the optical properties of mirrors and lenses.

In these days of hot and cold wars it is well to be reminded by the editor that when one of Lavoisier's French colleagues, who had been sent to help in the American Revolution, was captured by the British, he was released in recognition of his scientific attainments (page 335).

Another valuable service rendered by the editor consists of his inclusion of biobibliographical sketches of the scientists prominent in Lavoisier's correspondence. But here and there the editor has blundered. For example, Patrick D'Arcy began his studies in France in 1739, not 1769 (page 480). Charles LeRoy, a nonresident member of the Academy of Sciences, was designated correspondent of Jean-François-Clément Morand on 16 February 1774, not 19 February 1752 (page 416). The assertion (page 359) that Newton belonged "to the Unitarian sect" rests on flimsy evidence. In the list of Guyton de Morveau's publications, his 1782 memoir on chemical nomenclature appears twice (page 405). Document No. 281, dated 16 November 1775, should precede No. 280; the latter is misdated 28 October 1775 (page 508), although the correct date (28 November 1775) appears in the provisional index, which is supplied as a separate sheet not bound with fascicle II.

In like manner, Nos. 145 and 146 should come before No. 144. On 26 November 1770 Lavoisier wrote four letters, two of them (Nos. 145 and 146) from Charleville, and the other two (Nos. 144 and 147) from Stenay, a small town about 30 miles away from Charleville. While he was still in Charleville, he began No. 145, with the statement, "In a moment, sir, I shall enter the carriage to go to Stenay." Obviously, then, No. 144 (written at Stenay) is later than Nos. 145 and 146, which were composed at Charleville prior to Lavoisier's departure from that city for Stenay.

Three other documents (Nos. 173 to 175) form a related group, all undated. But the first two (Nos. 173 and 174) contain only the opening words of a section which appears in full in No. 175. Would it not have been better editorial judgment, then, to place No. 175 in front of Nos. 173 and 174?

An "errata" sheet rectifies some of the typographical errors in fascicle II. While we are all grateful to the editor for making available to us the correspondence of his eminent fellow-countryman, we may be permitted to hope that the forthcoming fascicles will maintain a level of excellence fully worthy of their subject.

EDWARD ROSEN
Massachusetts Institute of Technology

Craig and Faust's Clinical Parasitology. Ernest C. Faust and Paul F. Russell. Assisted by David Richard Lincicome. Lea & Febiger, Philadelphia, ed. 6, 1957. 1078 pp. Illus. $15.

This sixth edition of Craig and Faust's textbook of the same title has two new authors, Paul F. Russell and David L. Lincicome, who rendered editorial assistance. It is thoroughly revised, the text now exceeding that in the fifth edition by about 75 pages. There has been little change of emphasis in this edition; the greatest emphasis is still upon helminthic disease. The section on arthropods has been increased by about 14 pages, but that on protozoology has been reduced. In keeping with current needs, there has been greater emphasis on toxoplasmosis and visceral larva migrants. The book still retains the high standard of excellence of the earlier editions.

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Theories of Nuclear Moments. R. J. Blin-Stoyle. Oxford University Press, London, 1957. 89 pp. $1.40.

This monograph, *Theories of Nuclear Moments*, by R. J. Blin-Stoyle is the first to appear in a series aimed at the postgraduate reader. Within the short compass of 75 pages, the subject of nuclear moments is covered under the following chapter headings: "Electromagnetic multipole moments," "Measurement of nuclear moments," "Exchange currents and velocity dependent forces," "Nuclear moments of H^2, H^3 and He^3," "Nuclear models," "Magnetic dipole moments of odd A nuclei," "Electric quadrupole moments of odd A nuclei," "Magnetic dipole and electric quadrupole moments of odd-odd nuclei," "Moments of excited states of nuclei," and "Nuclear

magnetic octupole moments." There are also two appendixes, one on angular momentum states in quantum mechanics, the other on the observed and calculated moments of odd A nuclei.

Because of the very substantial progress of the subject of nuclear moments during the past decade, a monograph in this field is timely. This book serves to point out that "tho' much is taken, much abides" in the field of nuclear moments. As the title of this book aptly points out, there is at present no complete theory. The graduate student, and the post-Ph.D. graduate who wants to catch up with the developments in this neighboring field, will obtain from this book a summary of the accomplishments to date. However, without going to the original articles (which are listed in a very useful bibliography), the graduate student will find it difficult to obtain a thorough understanding of the present theories of nuclear moments.

As a summary of the observed moments of nuclei, this book is probably not to be strongly recommended. However, since the purpose of the book w to discuss the theories of nuclear moments, and since the predictions of the different models may differ appreciably, it might have been argued that precise statements of the observed values were not in question. Notwithstanding this, the observed values are often given in this monograph with expressions of accuracy. For instance, to take one ca the magnetic moment of cobalt-58 is given in Table 5 as 3.5 ± 0.3 and in Table 4, as 4.0 nuclear moments. In fact, the latest accurate determination given by Jeffries *et al.* is 4.052 ± 0.011 nuclear moments. In such a short monograph it is clearly impossible for the author to cover everything in the subject field, and Blin-Stoyle has taken here for his subject the theories of nuclear moments. Of these, this monograph provides an excellent summary, and it serves as an appropriate guide to further intensive investigations.

R. D. HILL

University of Illinois

Quantum Field Theory. H. Umezawa. North-Holland, Amsterdam; Interscience, New York, 1956. 364 pp. Illus. $9.75.

The difficulty in writing a book on quantum field theory lies in the rapidly changing nature of the subject; moreover, such changes are sometimes fundamental additions to our knowledge and sometimes quite ephemeral enthusiasms for a particular point of view. Quantum electrodynamics has reached the stage of making very accurate quantitative predictions, very high energy physics is still at the stage of classification, while pion physics is somewhere between these extremes. A text which attempts to deal with all aspects of quantum field theory is to be expected, therefore, to be of a rather uneven character in its material, and this is the case here.

H. Umezawa starts his book with a discussion of relativistic wave equations, and then there are two chapters on the quantization of free fields and three on interacting fields. The perturbation solution is discussed, and after the idea of renormalization has been introduced, the predictions of quantum electrodynamics are given in some detail. The book ends with four chapters on, respectively, the general theory of renormalization, damping theory, S matrix theory, and the theory of propagators. Since the book was written, new work has made part of it incomplete, and parts of the last four chapters are likely to become unfashionable, their permanent place being as yet unassured. But anyone wanting to understand relativistic quantum theory must know almost all of the material in this book and will find it a good mentor. There are many examples worked in the text, and it is also a valuable reference book. It is definitely a theorists' book—in particular, there is no discussion of pion experiments and their interpretation; but within these limitations it contains much material which is not to be found in any of the other books in English.

S. F. EDWARDS

University of Birmingham, England

Mosses of Indiana. Winona H. Welch. Bookwalter, Indianapolis, Ind., 1957. 478 pp. Illus.

This earnestly and conscientiously compiled manual will be helpful to advanced students and to serious amateurs in Indiana. The fact that most of the mosses found in Indiana are widely distributed throughout eastern North America makes this treatment appear more prosaic and less highly original that it otherwise might. The alphabetical listing of names of up to 75 counties for weedy and ubiquitous species that unquestionably occur in every county—and township—of Indiana occupies space that could better have been used for original observations and interpretations by the author. The uncritical listing of counties for the handful of truly interesting species does not offer much help for the reader interested in ecology and geographical distribution, since he must first find the counties on a map and then draw his own conclusions.

The great majority of the illustrations used in this book appeared originally in Sullivant's *Icones Muscorum,* in Bruch, Schimper and Gümbel's *Bryologia Europaea,* and in contributions to journals by many different authors; yet these original sources, surprisingly, are acknowledged neither in the introduction nor in the text.

In spite of the limitations mentioned, most of which, fortunately, will be taken seriously only by professional bryologists, this manual will take its place among the better moss floras of individual states.

WILLIAM C. STEERE

Stanford University

Scientific and Technical Translating. And other aspects of the language problem. United Nations Educational, Scientific and Cultural Organization, Paris, 1957 (order from Columbia University Press, New York). 282 pp. $4.20.

"Fifty percent of scientific literature is in languages which more than half the world's scientists cannot read." This generalization from the introduction of UNESCO's study of the language problem in the sciences would be hard to prove or disprove with fragmentary statistical evidence, but it does serve to explain UNESCO's concern with a vast intercultural problem.

The study is essentially a compendium of comments on a draft prepared for UNESCO by three national editors—Italian, French, and British—together with additional material supplied by the UNESCO secretariat. Its scope is large; the array of opinion, kaleidoscopic. There are comments and discussions on the statistics of scientific journals and on the language skills of scientists and techniques for improving them. The editors have devoted attention to the working problems of translating, to translating organizations and services, and to the status of machine translation, as well as to linguistic problems, including those of international languages and scientific lexicons. The book closes with extensive bibliographies, lists of contributors, and proposed solutions for one or more aspects of the problem.

The work is essential for those concerned with international scientific communication, yet the multitude of perspectives (preponderantly European) revealed in the comments on the UNESCO draft tend to hinder rather than assist in formulating the problem. Perhaps this is inevitable; the long shadow of the Tower of Babel follows even those who would escape it.

SCOTT ADAMS

National Institutes of Health

Cell Physiology. Arthur C. Giese. Saunders, Philadelphia, Pa., 1957. xvii + 534 pp. Illus. $10.

Cell Physiology is a textbook for undergraduates which, as the title suggests, lays emphasis on function at the cellular level. Since it is intended for students who may have had only introductory physics, chemistry, botany, zoology, and organic chemistry, the physical-chemical aspects are treated less rigorously in the text than is customary in intermediate or advanced textbooks of general physiology. Several of the chapters include an appendix which contains derivations or a more extensive theoretical treatment of some of the important physical principles.

The subject matter is divided into eight sections, each consisting of several chapters: "Introduction," "The Cellular Environment," "The Nature of the Cell and Protoplasm," "Exchange of Materials Across the Cell Membrane," "Nutrition," "Irritability and Response," "Protoplasmic Growth and Cell Division," and "History of Cell Physiology." The first section brings into perspective fundamental aspects of function and of applied plant and animal physiology. It also relates cellular physiology to basic principles of physical chemistry. The last section is a concise account of the origins of cell physiology and of some of the factors which shaped its development.

The treatment of the topics conveys both information and understanding. To achieve a broad coverage of the field within the limits of a book of manageable proportions for undergraduates has required restraint in the choice of pertinent examples. This choice has been made critically and with a fine sense of proportion. The result is a book that not only incorporates the important recent developments in cell physiology but also provides a broad background fundamental to the study of all the special fields within physiology.

Many of the illustrations are new. All are informative and attractively presented. The book is written in a clear and straightforward style and presents the material in a well-ordered arrangement.

References to recent monographs and reviews are listed at the end of each chapter. Papers cited in the text appear in a separate list.

F. G. SHERMAN

Brown University

New Books

A History of Technology. vol. III, *From the Renaissance to the Industrial Revolution, c1500–c1750.* Charles Singer, E. J. Holmyard, A. R. Hall, Trevor I. Williams, Eds. Clarendon Press, Oxford, England, 1957 (order from Oxford University Press, New York). 803 pp. $26.90.

The Ants. Wilhelm Goetsch. University of Michigan Press, Ann Arbor, 1957. 169 pp. $4.50.

The Stars. W. Kruse and W. Dieckvoss. University of Michigan Press, Ann Arbor, 1957. 202 pp. $5.

Behavioral Goals of General Education in High School. Will French. Russell Sage Foundation, New York, 1957. 247 pp. $4.

Roots of Scientific Thought. A cultural perspective. Philip P. Wiener and Aaron Noland, Eds. Basic Books, New York, 1957. 687 pp.

The Physiology of Fishes. vol. II, *Behavior.* Margaret E. Brown. Academic Press, New York, 1957. 537 pp. $14.

The Space Encyclopaedia. A guide to astronomy and space research. M. T. Bizony, General Ed. Dutton, New York, 1957. 287 pp. $6.95.

Reports on Progress in Physics. vol. XX. A. C. Stickland, Ed. Physical Society, London, 1957. 568 pp. £3. 3s.

A Textbook of Pharmacognosy. George Edward Trease. Williams & Wilkins, Baltimore, ed. 7, 1957. 816 pp. $8.50.

Light, Colour and Vision. Yves Le Grand. Translated by R. W. G. Hunt, J. W. T. Walsh, F. W. R. Hunt. Wiley, New York, 1957. 525 pp. $11.

Ideas, Inventions, and Patents. How to develop and protect them. Robert A. Buckles. Wiley, New York; Chapman & Hall, London, 1957. 285 pp. $5.95.

Mathematics and Wave Mechanics. R. H. Atkin. Wiley, New York, 1957. 363 pp. $6.

Cahiers de Synthese Organique. Methodes et tableaux d'application. vol. III. Léon Velluz, Ed. Masson, Paris, 1957. 266 pp.

Radiological Physics. M. E. J. Young. Academic Press, New York, 1957. 375 pp. $7.50.

Natural Magick. John Baptista Porta. A volume in *The Collector's Series in Science.* Derek J. Price, Ed. Basic Books, New York, 1957. 428 pp. $7.50.

Volumetric Analysis. vol. III, *Titration Methods.* Oxidation-reduction reactions. I. M. Kolthoff, R. Belcher, V. A. Stenger, G. Matsuyama. Interscience, New York, 1957. 723 pp. $15.

A Hundred Years of Evolution. G. S. Carter. Macmillan, New York, 1957. 216 pp. $3.75.

Catalysis in Practice. C. H. Collier, Ed. Reinhold, New York; Chapman & Hall, London, 1957. 158 pp. $3.95.

Science: How? Why? Wherefore? Edward M. Robinson and George T. Polk. Priory Press, Dubuque, Iowa, 1957. 261 pp. $2.50.

The Path of Carbon in Photosynthesis. J. A. Bassham and M. Calvin. Prentice-Hall, Englewood Cliffs, N.J., 1957. 114 pp. $3.

A System of Ophthalmic Illustration. Peter Hansell. Thomas, Springfield, Ill., 1957. 125 pp. $5.75.

Veterinary Toxicology. Formerly *Lander's Veterinary Toxicology.* R. J. Garner. Baillière, Tindall and Cox, London, 1957 (order from Williams & Wilkins, Baltimore). 415 pp. $7.50.

The Origins of Marxian Thought. Auguste Cornu. Thomas, Springfield, Ill., 1957. 136 pp. $3.75.

Perceiving: a Philosophical Study. Roderick M. Chisholm. Cornell University Press, Ithaca, N.Y., 1957. 214 pp. $2.75.

Schedules of Reinforcement. C. B. Ferster and B. F. Skinner. Appleton-Century-Crofts, New York, 1957. 749 pp. $6.50.

The Fishes of Ohio. Milton B. Trautman. Ohio State University Press, Columbus, 1957. 700 pp. $6.50.

Insect Life in the Tropics. T. W. Kirkpatrick. Longmans, Green, New York, 1957. 325 pp. $7.

The Story of Education. Philosophical and historical foundations. I. N. Thut. McGraw-Hill, New York, 1957. 420 pp. $5.95.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

Basic Research, a National Resource. 72 pp. $0.45. *Graduate Student Enrollment and Support in American Universities and Colleges, 1954.* 302 pp. $1.50. National Science Foundation, Washington, 1957 (order from Supt. of Documents, GPO, Washington 25).

Civil Air Regulations and Flight Standards for Pilots. Associated Aeronautical Staff. Aero Publishers, Los Angeles, ed. 18, 1957. 96 pp.

Atomic Energy Facts. A summary of atomic activities of interest to industry. U.S. Atomic Energy Commission, Washington, 1957 (order from Supt. of Documents, GPO, Washington 25). 216 pp. $2.

Automobile Exhaust and Smog Formation. Rept. No. 21. Air Pollution Foundation, Los Angeles, Calif., 1957. 103 pp. $3.

Life Insurance Medical Research Fund, Twelfth Annual Report, 1956–57. The Fund, 345 E. 46 St., New York, 1957. 92 pp.

A Symposium on Uranium and Uranium Dioxide. Nuclear Metallurgy, vol. IV. IDM Special Rept. Ser., No. 4. Metallurgical Society, American Institute of Mining, Metallurgical, and Petroleum Engineers, New York 18, 1957. 143 pp. $7.

A Chancay-Style Grave at Zapallan, Peru. An analysis of its textiles, pottery and other furnishings. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University, vol. L, No. 1. S. K. Lothrop and Joy Mahler, Peabody Museum, Cambridge, Mass., 1957.

Hair Structure as a Generic Character in Bats. Publications in Zoology, vol. 59, No. 8. Frances A. Benedict. University of California Press, Berkeley, 1957. 264 pp. $4.

Handbook of Toxicology. vol. II, *Antibiotics.* WADC Technical Rept. 55–16. ASTIA Document No. AD 130959. William S. Spector, Ed. Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1957 (order from ASTIA Document Service Center, Knott Bldg., Dayton 2, Ohio). 264 pp.

Meetings and Societies

Education in Engineering

Sixty-one deans of accredited engineering schools met in a 4-day conference at Purdue University, 9–11 Sept., to review recent developments in seven major fields of engineering and science and to consider the impact of these new developments on engineering education.

The seven major fields of subject matter were (i) computer development and applications; (ii) automation and automatic control; (iii) systems analysis and operations research; (iv) thermodynamics; (v) mass, momentum, and heat transfer; (vi) nuclear engineering; and (vii) solid-state physics and engineering materials. A recognized authority on each subject presented a survey of the field, and a second speaker discussed the impact on engineering education. One session was devoted to discussion of administrative problems, with special reference to trends in the cost of engineering education.

George A. Hawkins, dean of the Purdue Schools of Engineering, who was host to the conference, said that the idea of the meeting grew out of discussions in recent months with many of his colleagues in engineering administration. The program was planned by him with the assistance of associate dean Paul Chenea. At the close of the conference, Hawkins said that, from general comments of the group, it appeared to him that the problems of the future would be (i) the integration of subject matter and (ii) the development of a dual engineering program—one for those interested in the functions of research, design, development, and education and one for those interested in construction, maintenance, estimation, production, and sales—the former highly oriented toward mathematics and the physical sciences—and the latter with a strong foundation in mathematics and physical sciences but oriented toward the humanities. He emphasized that these are of equal importance in society.

Typical of many observations made by speakers was that of Gordon S. Brown (Massachusetts Institute of Technology), who suggested that universities create "centers of learning" in four general areas—namely, communication, energy exploitation, engineering materials, and mobility and transportation—cutting across conventional engineering departments. In similar vein, J. P. Nash (Lockheed Aircraft Corporation), speaking of the impact of computer development on engineering education, said that the increased use of computers affords opportunity for enriching the engineering curriculum with more of basic theory. Along the same line, Myron Tribus (University of California, Los Angeles), who with Newman A. Hall (Yale University) covered the field of thermodynamics, expressed a belief in the desirability of breaking through the boundaries between the divisions in engineering.

Referring specifically to rising costs of engineering education, R. W. Kettler (University of California) made half a dozen suggestions, among which he recommended a reduction in specialization and more emphasis on general courses; establishment of cooperative programs among institutions, where each can specialize in a particular field; and requiring students to assume more individual responsibility for learning. F. L. Hovde, president of Purdue University, in a banquet address, while speaking of administrative problems under pressure of increasing enrollment, emphasized the compelling necessity to minimize specialized engineering curricula and expressed the need for a new philosophy of "self-learning" on the part of the student, beginning in secondary school and extending throughout his academic education, whereby the process of being taught would be supplanted by development of habits of learning which might be continuous throughout his lifetime. Self-learning, said Hovde, would enable instructors to carry larger classes, and this, in turn, would make it possible to pay higher salaries.

Keen discussion by the engineering administrators was provoked by each of the speakers. Samuel Alexander (National Bureau of Standards) spoke of the possibility of reaching a billion-dollar figure in annual sales of computers by 1965, with corresponding pressure on universities for skills in design and manufacture. J. G. Truxal (Brooklyn Polytechnic Institute), speaking on automation, said that the marriage of computers and control systems was the most significant recent development and visualized the installation, 10 years hence, of a digital computer with a control system in a military plane to control all essential functions of the plane, including firing and navigation; he added that any student of automatic control is likely to wind up on a military project. H. H. Goode (University of Michigan) and D. G. Malcolm (Booz, Allen, and Hamilton) spoke on systems analysis and operations research.

E. R. G. Eckert (University of Minnesota) and R. B. Bird (University of Wisconsin), surveying the field of mass, momentum, and heat transfer, held that

Some of the 61 deans of accredited engineering schools who attended a four-day conference at Purdue University. (Left to right) E. H. Flath (Southern Methodist University); R. D. Landon (University of Akron); George F. Branigan (University of Arkansas); George A. Hawkins (Purdue University), who was host to the conference; and Howard K. Justice (University of Cincinnati).

undergraduate training in physics on the subjects of momentum transfer, energy transfer, and mass transfer is inadequate and that unnecessary duplication exists in various engineering departments; they recommended that transport processes be treated as a unified subject covering principles that are applicable to all fields of engineering. Stuart McLain, consultant in nuclear engineering, predicted that the greatest growth in industrial capacity in the next decade will be based on nuclear power, especially in Western Europe; he said that, because of lack of design and operational experience, many new plants will not be started before 1960. H. J. Gomberg (University of Michigan) said that the shortage of reactor physicists is so acute that engineers must be trained to take over more activities normally handled by physicists; he proposed a definite curriculum whereby engineers with sound basic training at the bachelor-of-science level could be given advanced courses in nuclear engineering.

J. E. Goldman (Ford Motor Company) and Glenn Murphy (Iowa State College), speaking on solid-state physics and engineering materials, stressed the need for more engineers with the basic training that, in the recent past, has been given in the realm of solid-state physics rather than in any branch of engineering. Murphy said, "All the products of an engineer's activities are expressed in terms of materials. There has quietly developed a science of materials to replace the art of materials. Within a few years no engineering graduate can hope to practice his profession in other than a subordinate capacity without knowledge of the science of materials."

The proceedings of the conference, which was financed by Purdue University and the Purdue Research Foundation, will be published in book form.

JAMES B. BALL
Purdue University, Lafayette, Indiana

NSF Travel Grants

The National Science Foundation will award individual grants to defray partial travel expenses for a limited number of American scientists who wish to participate in the following international congresses:

International Federation of Electron Microscope Societies, Berlin, Germany, 10–17 September 1958; deadline, *15 February 1958.*

International Congress of Americanists, San Jose, Costa Rica, 20–27 July 1958; deadline, *1 March 1958.*

Special Session of the International Statistical Institute, Brussels, Belgium, 1–6 September 1958; deadline, *1 March 1958.*

Application blanks may be obtained from the National Science Foundation, Washington 25, D.C. Completed forms must be submitted by the deadline date indicated for each meeting.

Society Elections

■ The Society of Rheology: pres., J. H. Dillon, Textile Research Institute; vice pres., J. H. Elliott, Hercules Powder Company; sec.-treas., W. R. Willets, Titanium Pigment Corporation; editor, R. D. Andrews, Dow Chemical Company.

■ Animal Care Panel: pres., Jules S. Cass, University of Cincinnati; vice pres. and pres. elect, Bennett J. Cohen, University of California; sec.-treas., Robert J. Flynn, Argonne National Laboratory, Box 299, Lemont, Ill.

■ The American Society of Tropical Medicine and Hygiene: pres., Donald L. Augustine, Boston, Mass.; pres. elect, Lewis W. Hackett, Berkeley, Calif.; vice pres., Paul C. Beaver, New Orleans, La.; sec.-treas., Rolla B. Hill, Miami, Fla.; editor, Martin Frobisher, Closter, N.J.

■ National Shellfisheries Association: pres., Melbourne R. Carriker, University of North Carolina, Chapel Hill, N.C.; vice-pres., L. Eugene Cronin, Maryland Department of Research and Education, Solomons, Md.; sec.-treas., Philip A. Butler, U.S. Fish and Wildlife Service, Gulf Breeze, Fla.

Forthcoming Events

January

17–18. Blood Symposium, 7th annual, Detroit, Mich. (W. H. Seegers, Dept. of Physiology and Pharmacology, Wayne State Univ. College of Medicine, 1401 Rivard, Detroit 7.)

22–24. American Council of Learned Societies, 39th annual, Bloomington, Ind. (ACLS, 2101 R St., NW, Washington 8.)

22–25. American Group Psychotherapy Assoc., 15th annual, New York. (M. Berger, 50 E. 72 St., New York 21.)

27–28. Scintillation Counter Symp., Washington, D.C. (G. A. Morton, Radio Corporation of America, Princeton, N.J.)

27–29. American Soc. of Heating and Air-Conditioning Engineers, Pittsburgh, Pa. (J. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

27–30. American Meteorological Soc., 163rd natl., New York. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

27–31. Institute of Aeronautical Sciences, 26th annual, New York, N.Y. (S. P. Johnston, IAS, 2 E. 64 St., New York.

28–30. Aging, 4th Ciba Foundation Colloquium (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

28–30. American Mathematical Soc., 64th annual, Cincinnati, Ohio. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

29–31. American Astronautical Soc., 4th annual, New York. (A. B. Crunden, AAS, 516 Fifth Ave., New York 36.)

29–1. American Physical Soc., annual, New York, N.Y. (K. K. Darrow, Columbia Univ., New York 27.)

30–31. College–Industry Conf., American Soc. for Engineering Education, 10th annual, Ann Arbor, Mich. (W. D. McIlvaine, College of Engineering, Ann Arbor.)

30–31. Mathematical Assoc. of America, annual, Cincinnati, Ohio. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

30–1. American Assoc. of Physics Teachers, New York. (F. Verbrugge, Univ. of Minnesota, Minneapolis.)

30–1. Western Soc. for Clinical Research, 11th annual, Carmel-by-the-Sea, Calif. (A. J. Seaman, Univ. of Oregon Medical School, Portland 1.)

31–1. Problems of Geriatrics, symp. (by invitation only), New York. (B. F. Chow, Johns Hopkins Univ., School of Hygiene and Public Health, 615 N. Wolfe St., Baltimore 5, Md.)

February

1–14. Pan American Assoc. of Ophthalmology, Caribbean cruise cong., sailing from New York, N.Y. (L. V. Arnold, 33 Washington Sq. W., New York 11.)

3–4. Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Del. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

3–7. American Inst. of Electrical Engineers, winter genl., New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

5–7. Biophysical Soc., Cambridge, Mass. (A. K. Solomon, Biophysical Lab., Harvard Medical School, Boston, Mass.)

10–14. American Soc. for Testing Materials, St. Louis, Mo. (F. F. Van Atta, ASTM, 1916 Race St., Philadelphia 3, Pa.)

13–15. National Soc. of Professional Engineers, spring, East Lansing, Mich. (NSPE, 2029 K St., NW, Washington 6.)

16–20. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New York. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

20–21. Transistor and Solid State Circuits Conf., Philadelphia, Pa. (J. H. Milligan, Jr., Dept. of Electrical Engr., New York Univ., New York 53.)

22–25. American Educational Research Assoc., St. Louis, Mo. (F. W. Hubbard, AERA, 1201 16th St., NW, Washington 6.)

24–28. American Soc. of Civil Engineers, Chicago, Ill. (W. W. Wisely, ASCE, 33 W. 39 St., New York 18.)

March

1. Junior Solar Symposium, Tempe, Ariz. (Association for Applied Solar Energy, 3424 N. Central Ave., Phoenix, Ariz.)

1–3. National Wildlife Federation, St.

Louis, Mo. (E. F. Swift, NWF, 232 Carroll St., NW, Washington 12.)

3. Wildlife Soc., annual, St. Louis, Mo. (D. L. Leedy, U.S. Fish and Wildlife Service, Washington 25.)

5–6. Gas Conditioning Conf., 7th annual, Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

6–8. Fundamental Cancer Research, 12th annual, Houston, Tex. (W. K. Sinclair, M. D. Anderson Hospital and Tumor Inst., Univ. of Texas, Houston 25.)

6–8. Optical Soc. of America, annual, New York. (A. C. Hardy, Massachusetts Inst. of Technology, Cambridge 39.)

10–13. American Assoc. of Petroleum Geologists, annual, Los Angeles, Calif. (R. H. Dott, AAPG, Box 979, Tulsa 1, Okla.)

10–13. Society of Economic Paleontologists and Mineralogists, annual, Los Angeles, Calif. (R. H. Dott, Box 979, Tulsa, Okla.)

16–21. Nuclear Engineering and Science Cong., Chicago, Ill. (D. I. Cooper, *Nucleonics,* 330 W. 42 St., New York.)

17–21. National Assoc. of Corrosion Engineers, 14th annual, San Francisco, Calif. (NACE, Southern Standard Bldg., Houston 2, Tex.)

18–20. Amino Acids and Peptides, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

20–22. Michigan Acad. of Science, Arts and Letters, annual, Ann Arbor, (R. F. Haugh, Dept. of English, Univ. of Michigan, Ann Arbor.)

20–22. Pulmonary Circulation Conf., Chicago, Ill. (Wright Adams, Chicago Heart Assoc., 69 W. Washington St., Chicago 2.)

20–23. International Assoc. for Dental Research, annual, Detroit, Mich. (D. Y. Burrill, Univ. of Louisville, School of Dentistry, 129 E. Broadway, Louisville 2, Ky.)

23–26. American Assoc. of Dental Schools, annual, Detroit, Mich. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

23–29. American Soc. of Photogrammetry, 24th annual, jointly with American Cong. on Surveying and Mapping, 18th annual, Washington, D.C. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

24–27. Institute of Radio Engineers, natl. conv., New York. (G. W. Bailey, IRE, 1 E. 79 St., New York 21.)

27–29. National Science Teachers Assoc., 6th natl., Denver, Colo. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

29. South Carolina Acad. of Science, annual, Charleston. (Miss M. Hess, Dept. of Biology, Winthrop College, Clemson, S.C.)

29–30. American Psychosomatic Soc., 15th annual, Cincinnati, Ohio. (T. Lidz, 551 Madison Ave., New York 22.)

30–3. American College Personnel Assoc., annual, St. Louis, Mo. (L. Riggs, DePauw Univ., Greencastle, Ind.)

April

1–3. Corrosion Control, 5th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

2–4. American Assoc. of Anatomists, annual, Buffalo, N.Y. (L. B. Flexner, Dept. of Anatomy, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

2–4. Instruments and Regulators Conf., Newark, Del. (W. E. Vannah, Control Engineering, 330 W. 42 St., New York 36.)

4–5. Southern Soc. for Philosophy and Psychology, annual, Nashville, Tenn. (W. B. Webb, U.S. Naval School of Aviation Medicine, Pensacola, Fla.)

7–11. American Assoc. of Cereal Chemists, annual, Cincinnati, Ohio. (J. W. Pence, Western Utilization Research Laboratories, Albany, Calif.)

8–10. Electronic Waveguides Symp., New York. (J. Fox, Microwave Research Inst., Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.)

9–12. National Council of Teachers of Mathematics, Cleveland, Ohio. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

9–14. Applied Psychology, 13th internatl. cong., Rome, Italy. (L. Meschieri, National Inst. of Psychology, Rome.)

10–11. American Inst. of Chemists, annual, Los Angeles, Calif. (L. Van Doren, AIC, 60 E. 42 St., New York 17.)

10–12. National Speleological Soc., annual, Gatlinburg, Tenn. (G. W. Moore, Geology Dept., Yale Univ., New Haven, Conn.)

10–12. Ohio Acad. of Science, annual, Akron, Ohio. (G. W. Burns, Dept. of

Botany, Ohio Wesleyan Univ., Delaware, Ohio.)

11. Vitamin B-12 Symp., New York, N.Y. (Miss J. Watson, 451 Clarkson Ave., Brooklyn 3, N.Y.)

11–12. Eastern Psychological Assoc., annual, Philadelphia, Pa. (G. Lane, Dept. of Psychology, University of Delaware, Newark.)

11–18. Horticultural Cong., 15th internatl., Nice, France. (Secretariat General, 84, rue de Grenelle, Paris 7e, France.)

13–14. American Soc. for Artificial Internal Organs, Philadelphia, Pa. (G. Schreiner, Georgetown Univ. Hospital, Washington 7.)

13–18. American Chemical Soc., 133rd, San Francisco, Calif. (R. M. Warren, ACS, 1155 16 St., NW, Washington 6.)

13–19. Federation of American Societies for Experimental Biology, annual, Philadelphia, Pa. (M. O. Lee, FASEB, 9650 Wisconsin Ave., Bethesda 14, Md.)

14–16. Automatic Techniques Conf., Detroit, Mich. (J. E. Eiselein, RCA, Bldg. 10–7, Camden 2, N.J.)

14–18. American Assoc. of Immunologists, annual, Philadelphia, Pa. (F. S. Cheever, Graduate School of Public Health, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

14–18. American Soc. for Experimental Biology, annual, Philadelphia, Pa. (J. F. A. McManus, Univ. of Alabama Medical Center, Birmingham.)

14–18. American Soc. of Biological Chemists, annual, Philadelphia, Pa. (P. Handler, Dept. of Biochemistry, Duke Univ. School of Medicine, Durham, N.C.)

15–17. Gas Measurement, 34th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

17–19. Association of Southeastern Biologists, annual, Tallahassee, Fla. (J. C. Dickinson, Jr., Dept. of Biology, Univ. of Florida, Gainesville.)

18. Iowa Acad. of Science, annual, Des Moines. (C. H. Lindahl, Dept. of Mathematics, Iowa State College, Ames.)

18–19. Arkansas Acad. of Science, annual, Little Rock. (L. F. Bailey, Botany Dept., Univ. of Arkansas, Fayetteville.)

19–21. American College of Apothecaries, Los Angeles, Calif. (R. E. Abrams, Hamilton Court, 39th and Chestnut St., Philadelphia, Pa.)

20–22. American Assoc. of Colleges of Pharmacy, annual, Los Angeles, Calif. (G. L. Webster, College of Pharmacy, Univ. of Illinois, 808 S. Wood St., Chicago 12.)

20–23. Chemical Engineering Conf., Canada-United States, Montreal, Quebec. (H. R. L. Streight, DuPont Company of Canada, P.O. Box 660, Montreal.)

21–23. American Oil Chemists' Soc., Memphis, Tenn. (Mrs. L. R. Hawkins, AOCS, 35 E. Wacker Dr., Chicago 1, Ill.)

21–28. American Industrial Hygiene Assoc., annual, Atlantic City, N.J. (G. D. Clayton, George D. Clayton and Associates, 14125 Prevost, Detroit 27, Mich.)

22–24. Electronic Components Symp., Los Angeles, Calif. (E. E. Brewer, Convair, Inc., Pomona, Calif.)

22–24. West Virginia Acad. of Science, annual, Morgantown. (M. Ward, Glenville State College, Glenville, W. Va.)

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ PHASE-ANGLE VOLTMETER provides 10-μv sensitivity as a phase-sensitive null indicator, with less than 5 μv of noise. Harmonic rejection exceeds 55 db. Full-scale voltage ranges of from 1 mv to 300 v are available for measuring signal magnitude and the quadrature or in-phase components of a signal. (North Atlantic Industries, Inc., Dept. S794)

■ MILLIVOLTMETER features zero-center indication. Input impedance is 2 megohm. Nine ranges up to 10 v d-c full scale, are selectable. Zero stability is said to eliminate the need for zeroing control. (Industrial Control Co., Dept. S806)

■ *p*H MEASURING UNIT, used in conjunction with a vibrating-capacitor electrometer unit, deflects full scale 0.1 *p*H at any point in the range from *p*H 3 to *p*H 10. Measurements are said to be accurate to ±0.002 *p*H units and the zero

point is said to be stable to the same figure in 12 hours. The units which make up the complete instrument are interconnected by flexible leads. (Robertshaw-Fulton Controls Company, Dept. S801)

■ SOUND SPECTROGRAPH makes a permanent aural record in addition to three visual analyses of vibrations in the 85- to 12,000-cy/sec range. The instrument can be adapted to subsonic vibrations. The record medium is a flexible magnetic disk 12 in. in diameter. The three visual records relate frequency and intensity to time; intensity, over a wider dynamic range, to frequency at a selected time; and amplitude of an over-all sample to time. Frequency response is constant within ±2 db. Bandwidths are 45 and 300 cy/sec. Recording time is 2.4 sec. (Kay Electric Co., Dept. S805)

■ FOLDER produces accordion folds in a long strip or roll of paper, such as the chart from an oscillograph or pen-and-ink recorder. A five- to tenfold increase in speed over the speed of manual folding is claimed. (Benson-Lehner Corp., Dept. S812)

■ VARIABLE-AREA FLOW METER is an all-glass instrument designed for research applications. Flow is sensed by a super-fine-finished float which rises or falls in a precision-bore glass tube to expose more or less of a V-shaped orifice cut in the wall of the tube. Standard flow-tube sizes are ½ in. and ¼ in., with ranges from 0.05 to 0.50 lit/min to 1.35 to 13.0 lit/min. Maximum operating pressure is 80 lb/in.² at 70°F; maximum operating temperature is 150°F. Other ranges can be furnished. (C-Mar Corporation, Dept. S810)

■ PHASE SHIFTER consists of resistance-capacitance networks, a phase inverter, and an output cathode follower. Phase-angle lag between input and output is shown on front-panel dials for 400 cy/sec operation. Range is 0 to 360 deg. Maximum error at 400 cy/sec is less than 0.1 deg. Maximum input signal is 25 v r.m.s. A correction curve permits use of the instrument at frequencies other than nominal. (Advance Electronics Lab., Inc., Dept. S808)

■ ELECTROPHORESIS APPARATUS features a chamber with built-in interlocks to prevent electrical shocks. The power supply will accommodate four chambers. Voltage is variable up to 500 v, current up to 50 ma. Each migration chamber will hold 20 ½-in. strips or 12 1-in. strips. (Labline, Inc., Dept. S813)

■ DIRECT-READING SPECTROGRAPHIC ANALYZER scans the spectrum of the specimen to be analyzed, stopping at selected lines according to a prearranged program. In this way only two multiplier phototubes are required, and continuous observation of instantaneous values of intensity ratio is permitted. A typical analysis of a metal alloy for six elements requires 57 sec. Dispersion is accomplished by a quartz prism system. In operation, outputs of the phototubes are fed to identical amplifiers and thence to an indicating milliammeter and a chart recorder. Signal amplification is based on spark modulation, thus permitting use of a-c amplification. (Intercontinental Electronics Corp., Dept. S820)

■ LABORATORY FURNACE, for temperatures to 1760°C, operates on any available fuel gas. Working temperature is reached in 1 hr and is held with fuel consumption of 160,000 Btu/hr. Charge space is 4½ in. in diameter and 2¾ in. long. By removal of a single element, the furnace may be converted into a lower-temperature unit with a larger charge space. (Selas Corp. of America, Dept. S816)

■ CRYSTAL-CONTROLLED OSCILLATORS are transistorized for compactness. Seated length is 5¼ in. and diameter is 1⅜ in. Output is 600 μw in the frequency range from 4 to 250 kcy/sec. Stability is ±0.015 percent from −40° to +60°C. Shock of 100 g and vibration of 0.03 in. total excursion at 5 to 55 cy/sec are tolerated. (Dynamics Corp. of America, Dept. S817)

■ SPEED-DEVIATION RECORDER indicates and records percentage deviation from a predetermined but adjustable speed. Input is received from a d-c tachometer generator and is compared with a stable d-c reference voltage. Accuracy is 0.1 percent. A variety of ranges is available; minimum span is 2 percent. (General Electric, Dept. S811)

■ MAGAZINE PROCESSER attaches to standard oscillographs and provides developed and dried photographic records as fast as the instrument records data. Development rates up to 25 in./sec are reached. Magazine capacity is 400 ft of 12-in. paper. Dimensions are 15½ by 13 by 11¼ in. (Consolidated Electrodynamics Corp., Dept. S815)

■ MICROPROJECTOR includes a horizontal stage, an inclined screen on which the enlarged image is viewed, and a choice of fixed magnifications from 10 to 100, selectable by interchange of lenses. The unit is self-contained on a rigid floor base. The stage opening is 4-in. in diameter, and the screen is 14-in. in diameter. (George Scherr Co., Dept. S819)

JOSHUA STERN
National Bureau of Standards

PERSONNEL PLACEMENT

CLASSIFIED: 18¢ per word, minimum charge $3.60. As of 1 January 1958, 25¢ per word, minimum charge $4.25. Use of Box Number counts as 10 additional words. Payment in advance is required.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

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26 times in 1 year	**20.00 per inch**
52 times in 1 year	**19.00 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS OPEN

(a) **Biochemist,** Ph.D., full-time research; experience with blood and tissue homogenate techniques important; research department, national organization; atmosphere similar to those in academic institutions; adequate technical and clerical assistance; medical school city; Midwest. (b) **Associate Medical Director;** preferably physician experienced in pharmaceutical field; major company, East. (c) **Virologist,** preferably Ph.D.; master's considered; duties consist of conducting survey of research organization; East; junior man, $8000; senior, $12,000–$17,000. (d) **Bacteriologist** trained in biochemistry; research in hypersensitivity, teaching; state university, West. (e) **Chemist** or **Biochemist** for research on steroids and hormones; duties include supervising research laboratory during absences of director; possibility university faculty appointment; Ph.D. preferred; M.S. with considerable experience eligible; West. S12-3 Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

Biological Research. Science information department of leading eastern pharmaceutical manufacturer desires research oriented scientist to participate in analysis and evaluation of scientific data. Background should include M.S. in one of the biological disciplines or equivalent industrial or research experience. Send complete résumé. Box 317, SCIENCE. X

Chemist, male, with B.S. or M.S. degree in organic chemistry, to participate in analytical biochemical research in mental illness in hospital near Philadelphia. Write stating age, education, experience, and salary desired to P.O. Box 8507, Philadelphia 1, Pa. 12/20, 27; 1/3, 10

CHEMISTS AND MATHEMATICIANS; Ph.D. preferred; teaching and research in expanding departments; salary dependent on experience and other qualifications. Inquiries should be addressed to Chairman, Division of the Natural Sciences, Dillard University, New Orleans 22, Louisiana. 12/20, 27; 1/3, 10, 17

Clinical Chemist, teaching and research institution, opportunity for individual work. Starting salary, $10,210. Box 318, SCIENCE. 12/27; 1/3

Microbiologist. Ph.D., recent graduate with experience or training in tissue culture and virology. Responsible research position with rapidly expanding veterinary biological and pharmaceutical manufacturer located in Midwest. Fine working conditions, liberal employee benefits, including a profit-sharing program, and excellent opportunity for advancement. Please send complete résumé, including approximate salary requirements, references, and date available in first letter. Our employees know of this ad and all inquiries will be held in strict confidence. Box 306, SCIENCE. 12/13, 20, 27

Ph.D. with training in bacteriology and virology to join team in research development of vaccines and their diagnostic methodologies. Salary open. Box 316, SCIENCE. X

POSITIONS OPEN

EDITOR
PHYSICAL SCIENCES

Major popular reference work, graduate degree or equivalent in physics or chemistry. Good general background. Editorial experience desirable. Excellent opportunity for person with right background to enter editorial field. Submit full résumé stating salary requirements. Applications should be mailed to: Editor-in-Chief, P. F. Collier Encyclopedia, 640 Fifth Avenue, New York 19, N. Y.

(a) **Pharmacologist;** Ph.D. to direct department of 25, report to research director; important company; to $15,000; East. (b) **Bacteriologist** and (c) **Biochemist;** M.S. to have full charge of respective sections, 275-bed general hospital; $5500–$6500; midwestern college city. (d) **Bacteriologist;** California public health certificate, degree, experienced; supervise four in clinical, research projects; new, large general hospital; to $6000; city 50,000. (e) **Chief Biochemist;** Ph.D. capable initiating, coordinating research program, clinical and basic levels; university affiliated 500-bed general hospital; to $8600; university city; Southeast central. Woodward Medical Bureau, Ann Woodward, Director, 185 N. Wabash Avenue, Chicago. X

Physical or **Photo Chemist** needed by medical research foundation presently engaged in research work in biologics and ultraviolet. Will be trained to assist and aid in supervision of investigational programs. Excellent, unusual opportunity available. Box 315, SCIENCE. 12/27; 1/3, 10

SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, $1.00. Yearly (12 issues) membership, $5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. ew

Tissue Culturist, M.S. or Ph.D. Culture of human cells. Opportunity to do independent research and graduate school work. Director, Roswell Park Memorial Institute, Buffalo, New York. 12/27

POSITIONS WANTED

Biochemist-Virologist, Ph.D., M.S., age 44. Extensive experience with contributions in analytical biophysical methods (electron microscopy, ultracentrifugation, electrophoresis). Recent investigations on potentialities of ultramicro analytical methods; immunochemical, ultraviolet microscopy, spectrophotometric, radioactive tagging. Strong background in public health laboratory research. Now employed in strictly administrative function (research evaluation) in nation-wide fund-granting agency. Capable of organizing and developing a combined biophysical-biochemical facility or department with microbiological orientation. Would consider semiadministrative position with opportunity to conduct and/or direct research program. Box 319, SCIENCE. X

Biostatistician, Ph.D., seeks university research affiliation; broad range of experience and publications; development of meaningful statistical systems and designs for clinical evaluation; background of application in psychiatry, psychopharmacology, chemotherapy in tuberculosis, epidemiology, and general medicine. Box 313, SCIENCE. 12/20; 1/3

Canadian, M.Sc., Physiology; experience in clinical chemistry, pharmacy, biochemical research; knows electronics, shop mechanics. Box 314, SCIENCE. 12/20; 1/3

Entomologist, Physiologist, Ph.D.; 1 year in experiment station work. Desires teaching position, with research opportunity, in zoology department. Box 320, SCIENCE. X

Immunochemist, Ph.D.; 12 years' experience in medical research during which time he has done considerable free-lance medical writing. Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

Microbiologist, Ph.D.; experience also in metabolism. Academic, bacteriology or others; academic or industrial research. Box 308, SCIENCE. 12/13, 20, 27

The MARKET PLACE

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While sexual reproduction is the rule among higher plants and animals in microorganisms it is much less common, and asexual reproduction in one form or another is almost universal. The genetic, physiological, and morphological evidence for "sex" in the principal groups of microorganisms — viruses, bacteria, fungi, unicellular algae, and protozoa—is presented by a group of experts in the field. The extensive bibliographies will prove very useful.

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APPLICATION FOR HOTEL RESERVATIONS

124th AAAS MEETING

Indianapolis, December 26-30, 1957

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in Indianapolis. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Indianapolis and thereby avoid delay and confusion. (Exception: Members of the American Astronomical Society who wish reservations at the Marott Hotel, 2625 North Meridian Street, are asked to correspond directly with that hotel.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague. Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 to 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Rates for Rooms with Bath

All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science*, July 19, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
Antlers	$4.50–10.00	$7.00–12.00	$10.50–12.00	$14.50–19.50
Claypool	7.00–10.00	9.50–14.00	10.50–14.00	13.50–34.00
Continental	8.00–10.00	8.00–12.00	8.00–12.00	12.00–15.00
Marott	7.00–14.50	9.00–14.50	10.00–17.50	14.50 and up
Severin	6.00– 9.00	8.50–12.50	11.00–15.00	25.00
Sheraton-Lincoln	6.50–11.50	9.85–15.00	13.35–16.00	24.35 and up
Warren	6.50–10.50	8.50–12.50	12.00–13.00	25.00–35.00
Washington	5.50–10.00	7.00–11.00	11.50–16.00	18.00–45.00

THIS IS YOUR HOUSING RESERVATION COUPON

AAAS Housing Bureau
1201 Roosevelt Building
Indianapolis 4, Ind.

Date of Application .....

Please reserve the following accommodations for the 124th Meeting of the AAAS in Indianapolis, Dec. 26–30, 1957:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

.....

.....

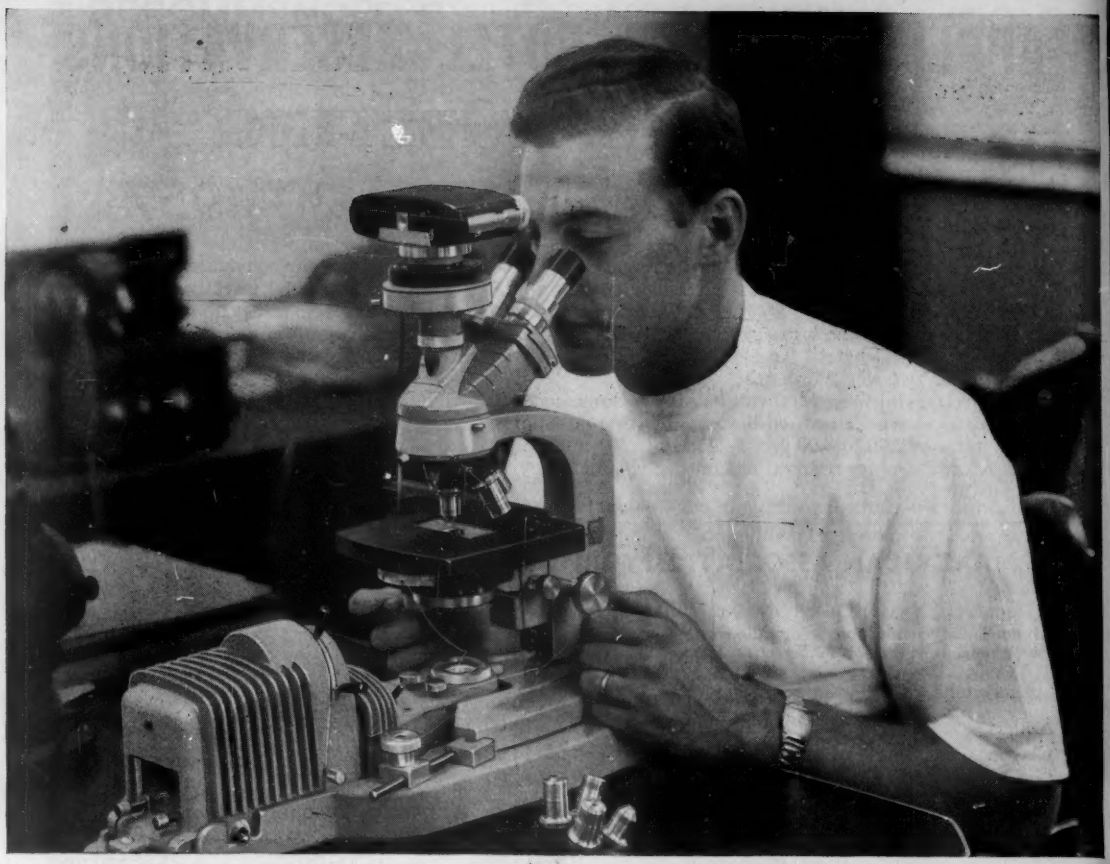
First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**



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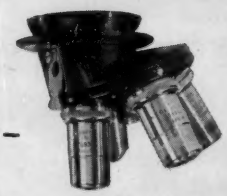

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